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An Interlude

During our recent visit to France, we took the opportunity to visit a few French foundries, and were received with that unfailing courtesy so typical of French industrialists. Time did not permit us to make a detailed investigation, but we received a few outstanding impressions. One of the concerns visited was an extremely large enterprise, actually one of the best known in Europe, and here we found the social services equal in every respect to those called for by the " Garrett " Report. Shower baths, with lockers for both day and working clothes, were provided at strategic points. A special building was in use for a medical welfare service. It was staffed by a part-time doctor and three qualified nurses and functioned both by night and day. The equipment, which included an X-ray apparatus, was equal to the best to be found in this country. The canteen during France's period of austerity served 1,500 or more midday dinners, but is now reduced under conditions of plenty to providing about 180 meals, as the workpeople prefer to eat at home. A serious effort was being made to smarten up the internal roadways by resurfacing and the planting of trees along their sides. The machinery was coated in either aluminium or yellow, giving an impressive appearance of modernity. The production was running at record levels; on the occasion of our visit, however, because of the annual holidays, one huge mechanised foundry was shut down. New moulding plant, involving the use of " roundabouts," was being installed, the design and manufacture being carried out internally.

A second foundry visited is also well known internationally. It specialises in the manufacture of rolls. Here was exactly the same high level of craftsmanship as is seen in this country. Moreover, the plant was of much the same sort. All the normal types of melting furnaces—pulverised-fuel-fired, air, cupola and electric—were in use. The technical control appeared to be in every way satisfactory. Like most of its counterparts in this country, attention could usefully be directed in putting more " showmanship " into a works which obviously lends itself to such treatment. With a few outstanding exceptions, the foundry industry has neglected this aspect.

Whilst in Paris, we were the guest of Mr. Le Thomas, the director of the *Centre Technique* for the inspection of the new central research station near Sèvres, and of the new offices they have acquired. Both are in course of reconstruction, and this is now well advanced. The former already houses a department for the testing and approving of various types of solid-fuel and gas-burning space heaters. When completed it will accommodate about 100 technicians and ancillary staff. The new offices are housed in a large mansion of real artistic merit. Internally, it is being reconstructed to give a modern suite of offices which will house the executive staff, numbering, with the secretariat and design office, between 100 and 150. Each office is decorated in a distinct tint to remove any resemblance to a " barracks." It should be remembered, when referring to the *Centre Technique*, that it caters for the whole of the foundry industry and, what is more, has every appearance of doing so in a remarkably practical and worthwhile manner.

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Foundry Management

Second Conference Reviewed

The Council of Ironfoundry Associations has now published a full account of the Second Conference on Management, which was held during the Spring at Ashorne Hill. The report is divided into four separate sections, corresponding with the four sessions held. The following subjects were covered:—(1) Productivity and Profit; (2) Human Relationships; (3) Amenities, and (4) Sales.

Productivity and Profit

In this session, two addresses were given, one by Mr. L. D. Hunter, a consultant, and the second by Col. W. A. Grierson, D.S.O. This first one covered a particularly wide field and was of real interest as it levelled-out the relative importance to be attached to the various phases of management. Only too often, after listening to a lecture, one receives the impression that it is only mechanical handling, or costing, or control, or some other feature, which matters. This Paper covered fairly well *all* the activities which go towards the creation of a well-conducted foundry, be it large or small.

The second address yielded much information that was new to foundrymen as a detailed description was given of the growth and decline of one section of the textile industry. The major point in Col. Grierson's remarks was the striking results to be obtained from deployment. This phase was seized on by a number of speakers as being of potential benefit to the jobbing founders.

Human Relations in Industry

As a basis for the discussion of this rather over-done subject, there were two Papers. The first was by Dr. C. B. Frisby, the director of the National Institute of Industrial Psychology, and the second by Mr. H. Weston Howard, C.B.E., chairman and managing director of Hayward-Tyler & Company, Limited. Because the second Paper was an actual account of how a firm instituted joint consultation "at all levels" (to use the modern jargon), there are a number of really useful points which, if implemented, will go far towards making a success of this internal co-operation. Apparently the "free" access provided to every detail of the financial and technical operation of the company, is like most other "free" things—taken for granted and largely ignored—except for the fact that its availability inculcates mutual trust and respect. The religious streak inherent in the make-up of the average citizen is shown to exist perhaps to a larger extent than is generally imagined and is obviously worth-while investigating and developing. About 10 per cent. of the author's employees attend in their own time the short religious services held weekly at the works.

Ablution Centres for Ironfoundries

This Report covers a sort of "brains trust" on the subject of sanitary blocks for ironfoundries. Four technicians, Mr. W. C. A. Matthewman, Mr. R. S. Reader, Mr. G. W. Buckley and Mr. R. L. Handley, formed the team, with Mr. J. Bolton as question master. The following points emerged from the discussion:—

(1) There should be a gap between the foundry and bathing rooms to avoid the penetration of dust.

(2) The "block" should be near the time office, so as to obviate delay in using the time clock. The centre of the foundry was a desirable site (which contradicts point No. 1).

(3) The suggested space allowance per man should be of the order of 10 to 15 sq. ft. with lockers one foot wide, 7 ft. 6 in. high, and a space 7 ft. 6 in. between each line.

(4) As it was desirable to maintain a temperature of 72 deg. F., excess space should be avoided.

(5) Where possible, gas decontaminating centres should be converted, as this would, very naturally, reduce initial cost.

(6) The National Coal Board's specification for tiled walls called for a height of 7 ft. 6 in., but 6 ft. was thought to be adequate. Terrazo flooring was specified.

(7) Duck boards should be avoided, as being dangerous.

(8) A special composition on a felt base has been found to be satisfactory for floors.

(9) Moderate roughness is advantageous, as it can hold a modicum of disinfectant.

(10) The question as to the relative suitability of lockers or wire baskets was left unsolved.

(11) For washing, the individual basins were the most popular. In any case, individual control of the taps was desirable.

(12) Thirty-two per cent. came to work well dressed.

(13) The cost of new buildings was of the order of £100 per man, and running costs 2s. 6d. to 3s. 6d. per man per week. Adapted buildings cost from £30 to £50 per man.

(14) In one case, the men paid 6d. a week and in return received soap and towel. For a daily intake of 127, the total weekly bill was £16 10s. or, less the 6d. contribution, £13 12s.

Selling Iron Castings

For this session there were two speakers—Mr. W. H. Harper, managing director of John Harper & Company, Limited, and Mr. C. J. Lake, chairman, Lake & Elliot, Limited. These two Papers can usefully be regarded as a preliminary survey, as iron castings differ in many respects from other commodities. Mr. Harper rightly favoured the services of high-grade salesmen. He criticised the exhibits at the British Industries Fair on the grounds of poor display practice. He supported the co-operation with a customer in the production of informative advertisements. Salesmen should be technically trained in order to give proper service.

Mr. Lake, in his Paper, stressed also that salesmen should be technical representatives and give service until a particular type of casting was well established in the works of the customer.

The publications mentioned in this review are obtainable from the Council of Ironfoundry Associations, 14, Pall Mall, London, S.W.1, at a cost to non-members of 5s. per set.

Symposium on Running Methods

The Connor Runner*

By J. F. Measures

This runner derives its name from its originator, Mr. F. J. Connor, of J. & E. Hall, Limited, Dartford, and to whom the Author is deeply indebted for permission to discourse upon this subject, and whose assistance and information has enabled him to put into use this runner. It is of a type that has undoubtedly saved many drawn castings.

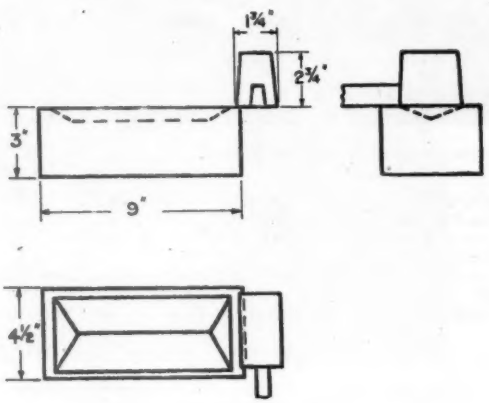

FIG. 1.—SKETCH SHOWING THE CONNOR RUNNER APPLIED TO A SIMPLE BRICK CASTING.

This runner is a small square block formed in the top part of a flat-top mould, so arranged that its bottom edge overlaps the top edge of the mould cavity. The length of the block must be such that when this overlap does not exceed $\frac{1}{16}$ of an inch, the speed of running is of a similar rate as when any other type of runner is employed. All that then remains now is to connect the block with a suitable downgate by means of a top gate, both being at least 25 per cent. greater in cross-section area than the ingate.

Before leaving the question of runner construction, one most important point must be stressed. On no account must the overlap between the block and the casting exceed $\frac{1}{16}$ in. This runner depends entirely upon this factor, regardless of casting weight or metal section. Any number of blocks may be used to run one casting, or, alternatively, any number of castings may be run from one block, the distance between the downgate and the block has no bearing on its success whatsoever. The Author has, on occasions, when limited for room in the box, been obliged to put the downgate directly on to the top of the block, but this practice is not recommended. On the other hand, the downgate has been 12 in. away from the block, and in each case successful results have been achieved.

As a simple example of this runner, Figs. 1 and 2 show it applied to the production of a cast-iron brick. This has been produced solely for demonstration purposes, as such a casting is notoriously difficult to cast free from shrinkage. Further examples are shown in Fig. 3 (*a*), (*b*) and (*c*), the last mentioned being particularly interesting in that it was necessary, in order to use this runner, to use a core fastened up in the top part of the mould so that the runner lipped on to the top edge of the casting. Fig. 4 shows the method of running adopted before this casting was run with a Connor runner, and Fig. 5, the details of the Connor runner as applied to it. By the previous method the removal of the riser took approximately five minutes, whereas the fettling time with the Connor runner is almost negligible.

Another local foundry, having seen this method of running, tried it out on the production of heavy wheel blanks which have to be gear or groove cut, and found it equally successful. Fig. 6 shows examples

FIG. 2.—PHOTOGRAPH OF THE BRICK CASTING WITH RUNNER ATTACHED. REFERRED TO IN FIG. 1.

*This and the two other Papers printed contiguously were presented to a meeting of the East Midlands Branch of the Institute of British Foundrymen, and formed the subject of a discussion on the running of castings as practised at the works of S. Russell & Sons, Limited, to which firm the Branch had made a prior visit.

Running Methods for Castings

of this application of the runner to comparatively large castings. Personal experiences of using this runner are limited to grey iron, and Table I shows the range of iron used and the characteristics of the

portant factor, for there are one or two conditions that must be guarded against. For example, whilst it is not suggested that any one would intentionally use a moulding box with $\frac{1}{16}$ in. of pin twist, should such an occasion arise and all the twist be in one direction, it would entirely shut off the runner, or,

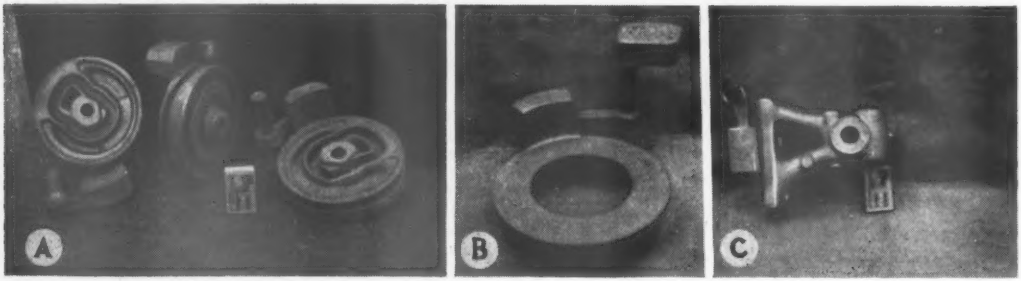

FIG. 3.—FURTHER EXAMPLES OF SIMPLE CASTINGS USING THE CONNOR RUNNER.

moulding sand, all castings being produced in green-sand moulds.

Precautions Necessary

It is felt that further emphasis must be given to the width of this runner abutting on to the casting, which should not exceed $\frac{1}{16}$ in. This is a very important factor, for there are one or two conditions that must be guarded against. For example, whilst it is not suggested that any one would intentionally use a moulding box with $\frac{1}{16}$ in. of pin twist, should such an occasion arise and all the twist be in one direction, it would entirely shut off the runner, or, alternatively, if in the reverse direction, it might double the width of the ingate. In either case the result would be fatal. The speed of running is a factor that is not very important, but it should be relative to the speed used with other types of runners; yet it is important completely to fill the block with metal as quickly as possible. This not only ensures

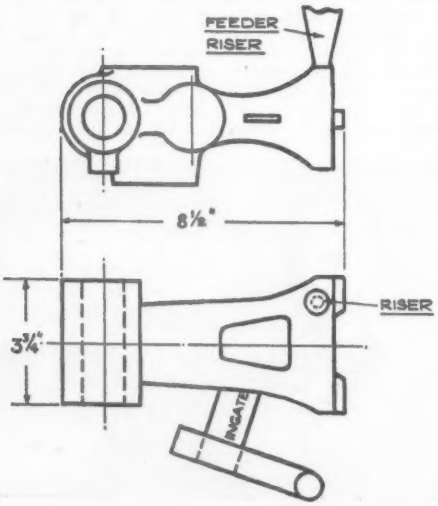

FIG. 4.—OLD METHOD OF RUNNING DRILLING MACHINE SPINDLE BRACKET.

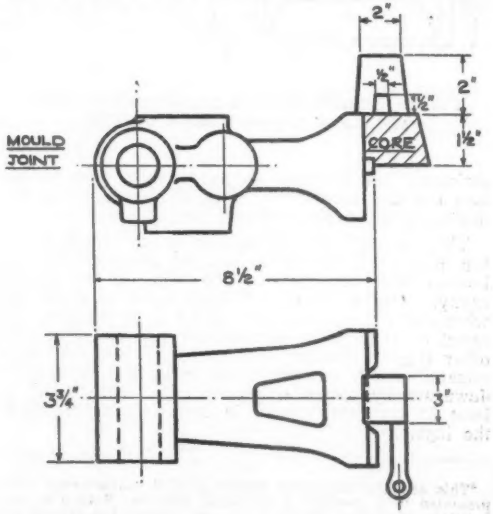

FIG. 5.—DRILL MACHINE SPINDLE BRACKET, SHOWING ADDITIONAL CORE.

a clean casting, but has a bearing upon the successful feeding. A well-proportioned downgate and top gate into the block will take care of this problem. Very slow running should be avoided, as this would involve the risk of a misrun casting, and with large castings, the top would draw-in. If running time be found excessive, then the length of the block should be increased, or if the size of the moulding box permits, a second runner could be introduced, but it must be stressed that the width of ingate must not be increased.

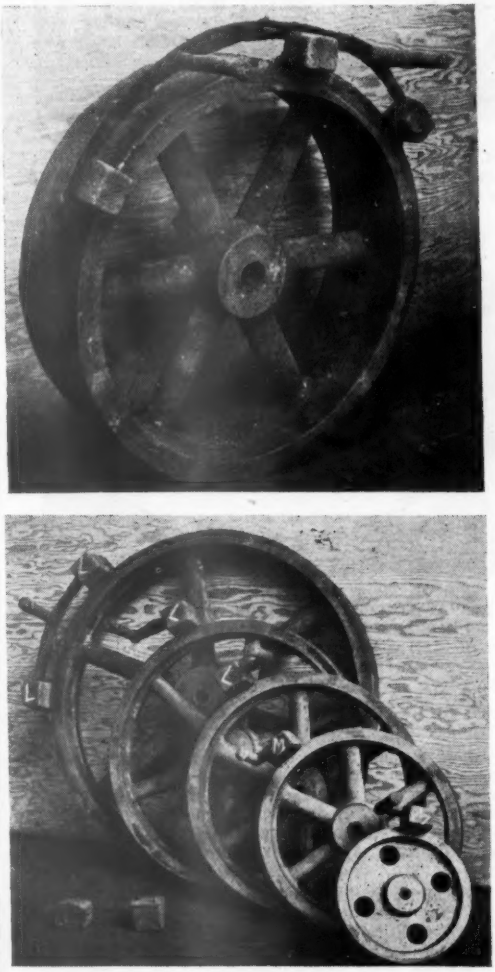

FIG. 6.—APPLICATION OF THE CONNOR RUNNER TO LARGE CASTINGS.

Thirdly, with the mould itself, precautions are necessary against the risk of a scab in front of the block or below it. The best method of avoiding this risk is to pay a little extra attention to the ramming of these parts of the mould and to use a carefully-controlled moulding sand. It must be borne in mind that this runner will not feed uphill, and, therefore, no point of the casting should be above the level of half the height of the block, and finally it should be stressed that the hotter the metal the better the results.

Two Failures

Referring to the earlier remarks as to the vast number of successes experienced, it should be stated that some failures have resulted, but these, fortunately, have been limited to two. One case was a solid block 3 in. by 2 in. by 1¼ in., which had a considerable number of small holes drilled through its smaller dimension. Each hole was subjected to a high pressure test and there had to be no leakage between holes, despite the fact that the holes were only ¼ in. apart. In this case the Connor runner failed, and so did every other runner, and finally these jobs had to be cast on end in the form of long sticks and parted off, as this was found to be the only means of producing a casting that would stand up to such a test. The second failure was on a gear blank approximately 12 in. diam. and about 1 in. thick. Very fine teeth were cut into this blank, each of which had to be perfectly sound, but out of 400 of such blanks, 75 machining rejects occurred, which showed porosity in one or more teeth. These castings were made during a period when the furnace coke was of very poor quality, and it is contended that the major blame for these rejects should be shouldered by the Coal Board.

An attempt has been made to illustrate and explain the virtues and uses of the Connor runner, and the question arises as to exactly why it functions with such success. This will have to remain unexplained, for after careful consideration the Author has found no solution yet which would merit the advancing of any scientific technical explanation.

Finally, the Author tenders his thanks to the directors of S. Russell & Sons for their help; to members of their staff; to Mr. Connor; Mr. Commons, and Frederick Parker, Limited.

TABLE I.—*Range of Irons and Sand Test Values where Connor Runners have been used.*

Cast Iron :—	Moulding sand :—
T.C 3.2 to 3.5 per cent. ..	Moisture content, 5 per cent.
Si 1.6 to 2.3 per cent.	Clay content, 8 per cent.
P 0.3 to 0.7 per cent.	Coal dust content, 10 per cent.
Tensile strength, 15 tons sq. in. average	Green strength, 8-10 lb. per sq. in.
	Permeability, 38 to 45.

Running Methods for Castings

The Distributed Runner

By P. A. Russell, B.Sc., F.I.M.

These notes refer to one particular method of running used for high duty cast iron of the 20 tons per sq. in. tensile and higher types. In these cases the carbon content is usually below 3.0 per cent., and well below the eutectic amount, with phosphorus below 0.1 per cent. They have a long freezing range, accompanied by fairly rapid growth of comparatively large dendrites from the mould face and the application of the "Connor" runner described by Mr. Measures is much more limited.

The Author has found that the best results are obtained if feeders can be entirely eliminated, giving, in the heavier castings, a smooth shallow surface sink, which can be taken care of by extra machining allowances on the top face. Where this surface sink can be produced, 100 per cent. internal soundness is almost certain.

To obtain this, the avoidance of hot spots is essential, and use is made of what is called the "distributed" runner. This is mainly suited to symmetrical work such as flywheels, gear blanks, clutch components, etc. It consists of a circular runner bar sometimes broken in two places to receive two down runners; this is connected to the casting by very small ingates, usually $\frac{1}{4}$ in. wide and $\frac{1}{16}$ to $\frac{1}{8}$ in. thick. The runner bar is very close to the pattern and the ingates very short. The first ingate should be at some distance from the down runner. Fig. 7 shows a cross section of the runner, and Figs. 8 and 9 show some applications, not all in high-duty iron. The handwheel (Fig. 8) is of special interest as (*a*) the curved surface prevents the use of the "Connor" runner,

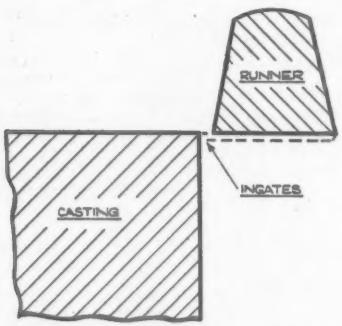

FIG. 7.—DISTRIBUTED RUNNER SYSTEM, SHOWING THE SHORTNESS OF THE INGATES IN RELATION TO THE SIZE OF THE CASTING AND RUNNER.

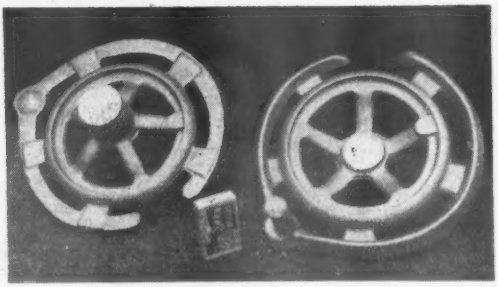

FIG. 8.—HANDWHEEL CASTINGS ON WHICH THE DISTRIBUTED RUNNER HAS BEEN USED. THE CURVED PERIPHERY OF THE RIM PREVENTS THE USE OF THE "CONNOR" RUNNER.

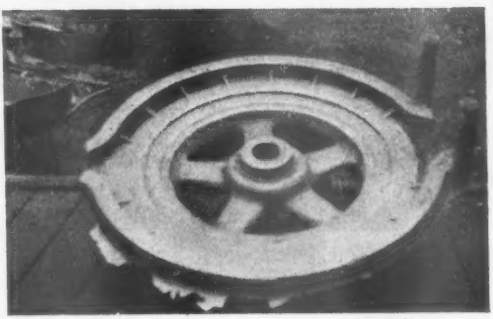

FIG. 9.—WHEEL CASTING USING TWO DISTRIBUTED RUNNERS.

(*b*) the ingates are arranged to avoid the hot spots caused by the arms, (*c*) the presence of a small boss determines the position of the down runner, *i.e.*, diametrically opposite.

It is difficult to get moulders to use the care necessary to cut runners of this type, and the whole success of it depends on the uniformity of ingate size and distance of runner bar from the casting; thus it is very desirable that the runner should be formed from a pattern.

This method is quite contrary to the principle of the "Connor" runner, and this is designed to promote uniform solidification rate throughout the casting, whereas the "Connor" runner depends on the hot metal of the block and surrounding area to promote directional solidification. The Author hopes that the posing of these two extremes will promote a good general discussion on methods of running castings.

Running and Feeding of Non-ferrous Castings

By D. W. Berridge

The first essential in non-ferrous foundry practice is careful control of melting and pouring temperatures, since these metals readily absorb gases when molten, the solubility increasing and decreasing with rise and fall in temperature. If pouring temperatures are too high, the gases will come out of solution after the casting skin has solidified, either causing micro-porosity, with inter-crystalline cavities, or gross porosity, with large gasholes which become evident as soon as the casting is machined. Pouring temperatures should therefore be as low as possible, compatible with complete filling of the mould and freedom from cold shuts.

Divergence from Ironfounding Methods

This calls for a different running technique from cast iron. Use is made of larger ingates and downgates, these being necessary also on account of the comparatively high liquid shrinkage. If small ingates be used they are often surrounded by small shrinkage holes, which may be due either to the gate feeding back from the casting, or to the release of dissolved gases at the hot spot caused because the slower running of metal provides extra heating up of the sand round the ingate. It is proposed to divide the metals into three groups:—(1) Gun metals and phosphor bronzes; (2) manganese bronze and aluminium bronze; (3) aluminium alloys.

Gunmetals do not present any great difficulties and quite large castings can be made in green sand. Wherever possible, small and medium castings should be run into a heavy section with a feeder runner, and with a short ingate of ample area. Often a dummy shrink knob is sufficient, but this can be brought through the top of the mould to give extra depth of feeder. The downgate should be placed a short distance from the knob, with a runner bar and slide gate leading into it to form a dirt trap; in effect, treating the knob as part of the casting.

Deep castings should be bottom run, owing to the risk with top running of trapping air and dross. In this case, feeders are necessary on the top, and these should have as short a neck as possible, tapering out sharply near the casting, and then less higher up. This keeps more hot metal close to the casting and gives better feeding than the plain V-shaped feeder. When pouring a row of moulds in gunmetal, trouble may be experienced with oxide skins, which form on the lip of the crucible, and are carried by the stream into the next mould. This can be prevented by the addition of a very small amount of 15 per cent. phosphor copper (2 ozs. per 100 lb.) just before pouring.

Phosphor bronzes can be run in the same way as gunmetals, but greater care is necessary in the positioning of the ingates, to avoid impingment on any cods or projections on moulds or cores. These metals are very fluid even at low temperatures and readily penetrate the sand. With phosphorus over 0.5 per cent., it is better to black and dry the moulds, even for quite small castings. Owing to high fluidity, top pouring can be used with less risk of entrapped air, and to give better directional solidification towards the top feeders.

Manganese bronze and aluminium bronze have two characteristics which make founding difficult, ready formation of dross, and high liquid shrinkage. The first must be overcome by a different running technique from gunmetals. Running should be as slow as possible, and at as low a temperature as possible, and should be at or near the bottom of the casting. A sump should always be provided at the bottom of the downgate to prevent splashing and to provide a cushion of metal. On small and medium castings extensive use can be made of feeder runners rather than top feeders, to give a considerable saving in weight of feed metal, and economy in fettling.

Use of Horn Runners

A good method of ensuring dross-free metal, free from turbulence, is to run underneath the feeder runner with a horn runner, having its larger end under the feeder knob, and, at the other end, a cross gate with sumps and with a side piece over the horn runner, small enough to act as a choke. If plain ingates be used they should be long, and flare outwards towards the casting to reduce the velocity of the stream, the smaller end again acting as a choke.

In larger castings, use can be made of horn runners directly on the casting, providing steps be taken to prevent a jet action which would cause drossing. One particular case where this method was used was a fairly intricately-cored gearbox weighing about 170 lb. This was run with three horn runners, the wall thickness being less than ¼ in., and the top almost entirely of this thin wall, with heavy internal and external bosses requiring heavy feeders. It was realised that the casting would have to be run quickly to prevent cold lapping on the top plate, but that this would be liable to cause dross formation, particularly when the first metal entered the mould. This was overcome successfully by having a single downgate 1¼ in. dia., with a sump, the two runners leading to the horn runners having bridge-type dross traps. Just before pouring, a clean mild-steel rod, 1 in. dia., heated to about 100 deg. C., was inserted into the downgate, effectively slowing down the flow of metal. When the bottom of the mould was well covered, the rod was withdrawn, thus increasing the pouring speed before the metal reached the top plate. Incidentally, it required 450 lb. of metal to pour this 170 lb. casting, a ratio necessary for quite a number of castings, which makes it difficult to adhere to the instructions of ingot suppliers not to use more than 50 per cent. remelt in the charges.

Self-feeders

Self-feeders for these metals should be of the type previously recommended for gunmetals, and must be used extensively. Chills must also be used a great deal, as only slight changes in section will lead to

Running Methods for Castings

shrinkage, usually at junctions. Care must be taken in the placing of chills, to ensure progressive solidification towards a feeder. For example, the placing of a chill on an isolated boss will not prevent it drawing, since its liquid shrinkage must still take place.

A trouble to which aluminium bronze is prone on thin sections is lapping, which has every appearance of cold-lapping. Increasing pouring temperature, however, does not cure this, but decreasing it often will, since it is caused by the oxide skin on the streams of metal preventing fusion, and higher temperatures cause these films to form more readily. In the moulding of these alloys, care must be taken in venting and blacking, especially for cores which have a thin plate of metal lying on them. For such cores the addition of sawdust to the sand helps to prevent fluttering, and if blacking be used it should contain very little gum, and be applied very thinly.

Aluminium Alloys

Aluminium alloys also are liable to dross formation, so the principal object in the running of castings is the prevention of turbulence, especially in those alloys containing magnesium. Multiple gating is the best method, since it also promotes equalisation of solidification and helps to prevent shrinkage and hot-tearing. A trouble encountered when running flat plates is seaming of the mould face where the metal stream flows across it. Here again multiple gating is a help, as it splits up the streams into a number of units which do not flow so far across the plate before joining up with others. This seaming and buckling on convex faces of the mould can also be prevented by using the sand very dry.

Deep runner bars, as used on the heavier metals, are not necessary on aluminium alloys, since, due to their low specific gravity, they will not float sand particles, and any dross formed has practically the same specific gravity as the metal, and so it will not float to the top. A deep runner bar may be used to feed through the ingates, but a better method is to use individual shrink knobs on each ingate, to give a better yield. Extensive use must be made of chills and feeders, the latter being preferred where feasible, owing to the tendency towards blowing from chills in green-sand moulds, especially in isolated pockets. Chills should be split into small units, and the larger ones should have $\frac{1}{8}$ in. dia. holes drilled through them, these being filled with sand before ramming up. Feeders should be of the type previously mentioned, with plenty of weight close to the casting, and not tall and narrow, as this is liable to cause shrinkage at the junction of the casting and feeder.

Where slight shrinkage is encountered around small bosses and in fillets, this can often be overcome by interrupting the pouring for a few seconds, as soon as the metal first enters the risers, and henceforward trickling metal through slowly until they are full.

DISCUSSION

MR. BUTTERS said the question of runners was a really fascinating subject. In the case of the Connor runner, as had been shown, there seemed to be some phenomenon attributed to this type of runner in as much as it did effectively produce a sound casting. He did not know whether any timing was taken with the Connor block system as against the normal system with two or three downgates. Everybody knew grey iron had a natural tendency to shrink when in bulk, and that shrinkage had to be compensated by feeding. It was said that the overlap must be $\frac{1}{16}$ in. Was the rate of flow so closely related to the rate of solidification for the speed of pouring to be necessary to the effectiveness of this runner? If not, how did the Author account for the fact that by moving it $\frac{1}{16}$ in. and leaving $\frac{1}{8}$ in. overlap prevented it from working. If the soundness was due to a feeding operation, one would imagine the movement of the block would facilitate feeding of the casting.

Rate of Running

MR. MEASURES said he stressed that the rate of running was not an important factor, one could pour as fast as one liked. The addition of a dozen runners, providing the blocks were not overlapping more than $\frac{1}{16}$ in., would be successful, but if the blocks were added on $\frac{1}{8}$ in. and the number reduced by half, thus running the metal at the same speed, it would not work. The reason was obscure, but probably the speed of pouring had no bearing on it whatsoever.

MR. BUTTERS asked whether there was any relationship between the area of the combined heads and the runner bar and the down runner.

MR. MEASURES, in reply, said he had discovered that the sand round the runner was heated. It was essential that one got the block of molten metal as hot as possible and as quickly as possible. The secret of success lay in that point. It would be noted, when the block was sectioned, that the cavity in the block was away from the casting and not towards it. The area of sand between block and casting became as hot as anywhere, the coldest part being away from the runner.

MR. BUTTERS suggested that the adjoining $\frac{1}{16}$ in. would solidify before any of the other.

MR. MEASURES, disagreeing, added that with an increase to $\frac{1}{8}$ in. it might happen.

MR. BUTTERS, referring to the fly wheel, illustrated by Mr. Russell, asked whether there was a definite relationship between the combined areas of these ingates, the runner bar and the downgates. Was it a cleaning reservoir or a dirt trap? In the case of high-duty iron giving a short freezing range rather than the reverse, the runner bar, if it was going to do any feeding, was $\frac{1}{8}$ in. away from the casting. Would the metal remain fluid enough?

MR. RUSSELL, in reply, said the runner bar size was carefully worked out in relation to the ingate area. The runner bar acted as a dirt trap. The freezing

range, through being a low carbon iron, gave high initial freezing point. Iron in the riser tended to clog the original channels, although a personal opinion was that a certain amount of feeding took place through that runner. The success was due not to feeding from the runner bar, but to the absolute uniformity of feeding due to solidification at a uniform rate, and therefore there was no shrinkage.

Effect of Overlap

MR. HILL said he was still concerned as to the effect created by the $\frac{1}{16}$ in. overlap. His first experience of this method of feeding was to use a round block, and in this case there was no doubt that it effectively fed the casting; it was limited to the maximum area of casting that it was possible to overlap without fear of breaking into the casting when removing the block. A few years ago he had had trouble in feeding a solid block of metal 3 ft. by 5 ft. by 1 ft. thick. The casting weighed about 3 tons. A rectangular block was eventually used solely as a feeder, the runner being placed in another position entirely. The block was made the entire width of the casting, and overlapped $\frac{3}{4}$ in., and the casting was found to be perfectly sound. In this case, had the foundry only used an overlap of $\frac{1}{16}$ in., it was difficult to conceive that the casting would have been sound.

MR. RUSSELL said that he had used this type of block runner, and had made castings which would otherwise have presented considerable problems. He was personally convinced that it was something to do with the feeding. He was not entirely satisfied that this $\frac{1}{16}$ in. figure was an absolute figure. He thought that the type of iron which Mr. Measures had used, $\frac{1}{16}$ in., was a critical figure, but for different types of iron there were probably different critical figures. If it was placed too far over, one had a porous line where metal had not fed down. There did seem to be a critical freezing rate between the very narrow neck of the block and the casting itself.

MR. MEASURES said he had used the runner referred to by Mr. Hill prior to using the Connor runner, and it was very efficient. As regards putting the block on and treating it as a riser, he had no confidence in it for this purpose. The secret of success was to use it as a runner only.

Rate of Running and the Shrinkage

MR. BOLTON said that the total amount of shrinkage which had taken place in the sectioned feeder shown by Mr. Measures seemed small in comparison with the size of the casting it had fed. This suggested that the rate of running the casting might be having an influence on the amount of liquid shrinkage which had to be satisfied. Perhaps the metal entered the mould so slowly that solidification took place progressively as the mould filled, and the final liquid shrinkage in the casting was thus minimised.

A further point was that irons in the range of compositions mentioned, would have a relatively low shrinkage. Would it be expected that similarly successful results would be obtained with an iron more prone to shrinkage troubles, say one with the phosphorus content round 1.6 per cent.? Mr. Measures had said that the feeder block should overlap the casting by $\frac{1}{16}$ in., and that the runner bar should have an area 25 per cent. greater than the ingate. He suggested that the unsatisfactory results obtained when the overlap was greater than $\frac{1}{16}$ in. must have been due to the block being accidentally pushed further over the casting without providing for a corresponding increase in the area of the downgate and runner bar. Had any experience been obtained with a wider ingate, but with a runner bar large enough to ensure that the block was kept full while the casting was being run?

MR. MEASURES replied that he had no experience, as all the castings were machine moulded, and the feeder block was never out of position. The pouring time of the castings referred to was not checked, but the running time on the casting referred to was under 10 seconds. The composition was within a range of 0.3 to 0.7 per cent. phosphorus, and this was the only metal with which experience had been gained with this particular type of feeder. It was just as successful with 0.7 as with 0.3 per cent. phosphorus.

MR. GOODWIN, referring to the small bracket, which was run at the side, and gave a hard area in the bottom flange, said this was to be expected. The result depended on the temperature of the metal, the coolest metal went back into the bottom end all the time, whereas with the new running system there was hot metal on the top continuously. As to Mr. Russell's distributive runners, he confirmed that the principle ensured progressive solidification.

Ignorance on Subject

MR. ROXBURGH said it seemed strange that foundrymen were so ignorant on this subject. There was so little recorded scientifically and so much was left to personal experience. The literature of the subject revealed that the late Mr. Ronceray was amongst the first to publicise the idea of the progressive solidification of the casting by the use of pencil runners, and if one made a simple casting such as a bush, this could be run from the top with pencil runners, and a sound clean casting was ensured. Personal experience with malleable cast iron was that any attempt to run a casting from the top with pencil runners would give trouble, unless accompanied by feed metal.

There were certain fundamental things to remember, and amongst them was the equal distribution of the metal in the case of the distributive runner, and the speed of running, pressure and feeding in order to get the solidification by the block runner. He had tried the block runner on malleable, and had had some interesting experiences. Any attempt to make malleable castings by methods similar to those Mr. Measures had described where one had $\frac{1}{16}$-in. overlap over the casting, and in the direction in which he had shown, would certainly be unsuccessful. It was necessary to put the runner on malleable as a circular block runner, and move it further on to the casting in order to obtain soundness.

Running Methods for Castings

Where it was a plain uniform casting in malleable there was certainly a possibility of using the Connor runner, but it should be noted that it would not answer for every type of casting and certainly had limitations. He asked whether Mr. Measures had investigated the effect of different types of blocks, and whether the height or size of the block made any difference to the results obtained.

MR. MEASURES, in reply, said he started with a big block, and progressively reduced it. The casting dealt with was made on an ordinary squeeze machine, the squeeze head compressing the sand on top of the block, but little or no effect could be made by the squeeze of the mould, and it had to be worked with the very bare minimum of hardness. The height of the block had little bearing on the result, the one indicated being only 1¼ in. high. He had never tried the Connor system on non-ferrous metals, and doubted if it would be effective at the lower temperatures used.

Effect of Composition

MR. PAYNE said that when dealing with the application of feeders to grey cast iron, there were to be considered many factors, of which the main ones could be listed as composition, pouring temperature, rate of cooling from that temperature, and the influence of mould material. Taking first the effect of composition, one could start with a low carbon iron or steel, this, on solidifying, exhibited a reduction in volume or shrinkage. The presence of carbon in the combined form did not materially affect this shrinkage. If, however, the iron carbide decomposed to give graphite, then a constituent was present which occupied roughly three times the volume of the equivalent weight of carbide from which it was formed. Thus for every one per cent. by weight of carbon in the combined state which broke down to form graphite, a 3 per cent. increase in volume occurred. In the case of cast irons within the range of composition where the Connor or block runner was effective, the percentage of graphite would be 2½ to 3, giving 8 to 10 per cent. increase in volume as against the same weight of carbon in the combined state.

Two Cases

The influence of this graphitisation upon solidification shrinkage could best be pictured by taking two possible cases. In the first case, due to the combination of suitable pouring temperature and cooling rate (*i.e.*, casting section), graphitisation occurred simultaneously with solidification. As the iron matrix was contracting, the newly-formed graphite was causing an expansion which partially or completely compensated for the shrinkage. If, however, the alternative case applied and the metal was left in the ladle until graphitisation had commenced, or if the pouring temperature was so high that the metal remained in the liquid condition in the mould for a sufficient length of time that graphite formation started before solidification, then the expansion due to this reaction would have taken place before the liquid to solid contraction, so that its neutralising effect was much reduced. Fast cooling from a moderately high temperature was more likely to give the desired counterbalanced effect.

Influence of Mould Material

The influence of the mould material had a great bearing upon the cooling rate, and it was probably this factor rather than the weight of the casting poured which determined the width of opening between the block and the casting. As the hot metal met the cold mould face, the metal was cooled and the sand was heated. The rate of heat flow through the sand was very low, and the temperature at the surface approached that of the metal. Where there was a narrow channel through which a considerable flow of metal occurs, the walls of the channel are raised to such a high temperature that these in turn serve to reduce the rate of cooling of the metal ultimately remaining in that narrow opening, giving, in effect, the same result as would be expected from a wide connecting neck between block and casting. Due to its comparatively small area, however, the running of the casting was fairly slow, and of course, the hottest metal tended to be at the higher regions of the casting and in the block itself, thus leading towards a progressive solidification.

It was probable that this type of runner also helped to achieve that comparatively rapid cooling in the mould which enabled the precipitation of graphite to balance the shrinkage of the matrix. In the opinion of the speaker, the provision of conventional feeder heads for this class of cast iron would aggravate the condition which it was supposed to remedy. By providing a large mass of slowly cooling metal to compensate for liquid shrinkage, it was feasible that graphitisation would be well on the way in the neck of the feeder before this commenced to freeze over, and the normal liquid shrinkage would occur at this point, giving a combination of coarse graphite and open metal, or even actual cavities.

In illustration of this point, was the experience some time ago, in one of the foundries with which the speaker was connected. The castings concerned were approximately 14 in. square, of an open-top box shape, the bottom of the box being 2 to 3 in. thick, and the sides of the box some 4 in. deep by ¾ in. thick. Considerable machining was carried out on the bottom face, and soundness was essential. The provision of heavy feeders with 3 in. square necks was tried, only to meet with failure because of the openness immediately beneath the riser. This same casting was now produced in daily quantities with no feeders whatsoever, but with due attention to the distribution of metal and the size of gates used.

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Stress-relief Heat-treatment of Alloy Cast Iron*

By M. M. Hallett, M.Sc., F.I.M. and P. D. Wing, Assoc. Met.†

Introduction

During the last ten years a fair amount of work has been done on the stress-relief of iron castings, and the findings have been summarised by the report of Sub-committee T.S.17 to this Institute.[1] Since a survey of the literature has been given in the T.S.17 Report, only a few passing references are made in the present paper, in particular, to the interesting work of Tottle,[2] who disclosed appreciable stress relief, even at room temperature. Much of the work reported by the Sub-committee was devoted to ordinary grey iron, though Benson and Allison[3] also studied steel and some non-ferrous metals. During the production of castings of high alloy materials, information has frequently been needed on the stress-relief treatment of such irons. The present work covers a range of high- and low-alloy cast irons.

With one or two notable exceptions, the earlier work has been qualitative in the sense that the stresses present were not accurately measured and the reproducibility of the results on stress relief has sometimes left something to be desired. Furthermore, it was felt that the magnitude of the initial internal stresses might well be a factor in determining the amount of stress relief at a given temperature, bearing in mind that the process of stress relief is essentially one of slow plastic deformation, *i.e.*, creep. No information could be found bearing on this question in cast iron, though a certain amount of data was published by Benson and Allison[4] for steel castings. It was also felt that there was need for more work on the relative merits of stress-relief treatment and of weathering, following the work of Tottle.[2] Although Tottle demonstrated more plastic deformation at room temperature than many people had expected, it must be remembered that the actual magnitude of relief was not very high with steady stressing and reached really useful proportions only with incremental stressing, a process which does not arise in stress-relief treatment of ordinary castings. It is hoped that the present work will contribute to the furnishing of a more complete picture of the whole operation of stress-relief treatment.

Experimental Procedure

Much of the earlier work was performed on castings which had been designed to induce considerable internal stress, the precise magnitude and nature of which was not determined. It was considered advisable in the present investigation to start with a simple form of test piece, and to impose on it a known stress, and to measure the relief of that stress following a series of planned treatments. A ring form of test piece was adopted because of its simplicity and sensitivity. The rings were parted-off from tubular castings, and were carefully machined to the same dimensions, and a gap of a constant width was cut in all specimens. It was also felt to be desirable to avoid possible complications from unknown stresses which might have persisted from the casting, and, to obviate these as far as possible, all the specimens were subjected to preliminary stress-relief treatment at 550 deg. C. for one hour, which a survey of the literature indicated as sufficient to remove a considerable amount of stress, while being perfectly safe from the point of view of possible disturbance of the microstructure or mechanical properties. These relatively stress-free rings were then slipped over a former, which opened the ring to a definite gap, thus imposing on the ring a stress which could be calculated from previous calibration of identical ring specimens by application of the empirical formula used for calculations of tensile strength in the piston ring type of test piece, *viz.*,

$$S = \frac{PD}{1200\, b\, t^2}$$

Where S = stress in tons per sq. in.,
P = load in lb.,
D = external diameter of the unsplit ring in inches,
b = axial breadth of ring in inches, and
t = radial thickness of ring in inches.

The arrangement of the ring on the spacer wedge is shown in Fig. 1. The ring and the wedge (which was in "Enduron," a heat-resisting 16.0 per cent. chromium cast iron), were then placed in a laboratory electrical resistance furnace and raised to the desired temperature for the desired time. After removal from the furnace, the ring was taken from the spacer wedge and the free gap measured. If the free gap, on removal from the spacer wedge, remained equal to the width of the wedge, then plastic deformation had occurred at the elevated temperature to an extent which had caused complete removal of stress. If the ring sprang back to its original gap on removal from the spacer wedge, it was considered that no relief of stress had occurred. Intermediate dimensions of gap corresponded to a linear reduction in stress.

Allowance had also to be made for the fact that, in cast iron, a certain amount of plastic deformation occurs at room temperature attendant on the opening-up of a ring form of specimen in the manner described. This

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had to be allowed for in calculating relief of stress, and the plastic deformation which occurred at room temperature was, therefore, subtracted from the total deformation. On these considerations, the formula used to calculate relief of stress was:

$$R = \frac{G_2 - G_1 - P}{W - G_1 - P} \times 100.$$

Where R = per cent. relief of stress,
G_2 = width of gap after removal from the spacer wedge in inches,
G_1 = width of original gap in inches.
W = width of spacer wedge in inches,
P = plastic deformation at room temperature ($= G_2 - G_1$ determined on calibration specimens at room temperature).

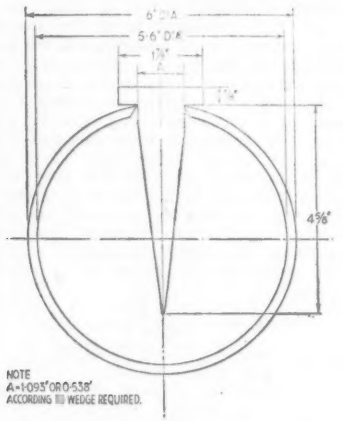


FIG. 1.—ARRANGEMENT OF TEST-RING AND SPACER WEDGE.

In order to study the effect of the magnitude of the original stress, two spacer wedges were employed, one of which imposed a stress of approximately 15 tons per sq. in. on the grey iron, and the other a stress of approximately 7 tons per sq. in., as determined by preliminary calibration tests. The same spacer wedges were used for all four materials, but the stresses imposed on the austenitic iron, and particularly on the 33 per cent. chromium cast iron, were different because of the difference in modulus of elasticity values of those two materials. The actual stresses are indicated in the relevant tables.

The final procedure was to mount, on each of the two spacer wedges, duplicate rings of the same material. The assembly was then placed in the furnace and heated for 1 hr. at the desired temperature, as indicated in the tables. On completion of the hour, the assembly was removed from the furnace and the ring was gently taken from the spacer wedge, and the gap again measured. Air cooling was felt to be unobjectionable on the light, even section of the test rings, but it is certainly not suggested that air cooling from the treatment temperature should be applied to castings in production. As mentioned above, some additional work was done on the effects of time of heating, both at 450 deg. C. and at room temperature. After measurement of the gap, the rings were subjected to the normal mechanical tests to determine the modulus of elasticity (En) and tensile strength.

Experimental Materials

The test rings were machined from tubular castings of normal sand-cast engineering grey iron (STA/8), centrifugally cast liner iron (Loded Centricast), centrifugally cast austenitic iron (Ni-Resist of high phosphorus content), and centrifugally cast 33 per cent. chromium iron. The compositions of these four materials are set out in Table I. They are normal, except that the chromium content of the Loded Centricast and the carbon content of the Ni-Resist are usually higher. Some additional work was done on sand-cast austenitic iron (Ni-Resist of low phosphorus content).

TABLE I.—*Composition of Experimental Materials.*

Element.	Composition per cent.			
	STA/8 sand cast.	Loded Centricast.	33 per cent. chrome iron Centricast.	Ni-Resist Centricast.
T.C. ..	3.20	3.25	1.35	2.16
Si	2.01	3.01	2.01	2.08
Mn	0.89	0.94	0.68	0.75
P	0.17	0.73	0.10	0.84
Ni	<0.10	<0.10	—	15.19
Cr	0.14	0.55	34.3	1.76
Cu	—	—	—	7.11

In order to avoid possible variation in properties, due to the rings being machined from different positions along the pot, the duplicate test rings treated at any one temperature were always taken from widely differing positions along the cast pot, so as to give a fair average value. In fact, the results on relief of stress were found to be very satisfactorily reproducible, and, as will be seen from a study of the tables, the duplicate test rings gave closely similar results.

Results

The results obtained, using the procedure described above, are considered in relation to the individual materials.

STA/8.—Table II gives complete details of the relief of stress and of the mechanical properties of the rings after exposure to the stress-relief treatment operation. Attention has already been drawn to the satisfactory agreement between the duplicate stress relief test rings treated under the same conditions. Average values have been calculated for relief of stress at each initial stress at each temperature and for the mechanical properties after exposure to each temperature.

From these data, curves have been drawn connecting percentage relief of stress with temperature of treatment (see Fig. 2). The curves, both for the high initial stress of 15 tons per sq. in., and for the low initial

stress of 7.5 tons per sq. in., follow approximately parallel courses differing by only a few per cent. As was expected, the relief of stress for a given tempera-

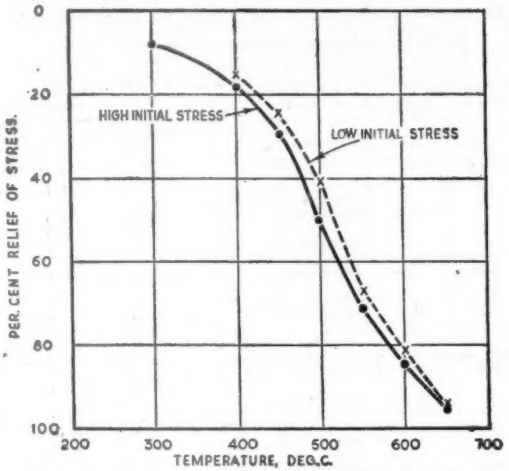


FIG. 2.—PERCENTAGE RELIEF OF STRESS ACCORDING TO TEMPERATURE FOR STA/8 MATERIAL.

ture is found to be greater the higher the initial stress, though the difference is only slight. The degree of stress relief achieved at any temperature falls within the range covered by the earlier literature, as summarised in the Report of the T.S.17 Committee.[1]

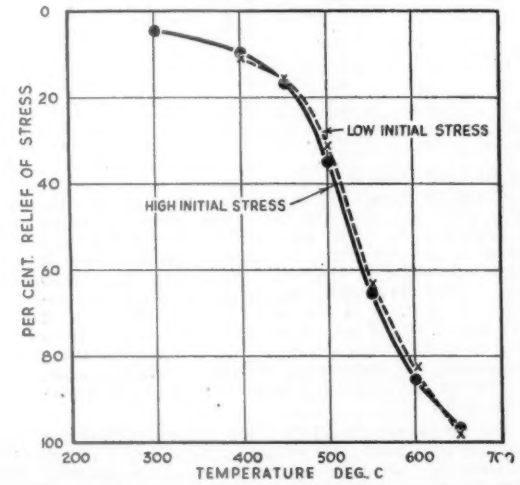


FIG. 3.—RELIEF OF STRESS ACCORDING TO TEMPERATURE FOR LODED CENTRICAST MATERIAL.

The mechanical properties in Table II show the

TABLE II.—*Stress-relief Tests on STA/8 Material.*

Temp., deg. C.	Applied stress, tons per sq. in.	Result.	Per cent. stress relief.	En. × 10⁶, lb. per sq. in.	Tensile strength, tons per sq. in.
300	15.0	Individual..	8.0	15.8	19.2
400	7.5	,,	16.1	16.8	21.1
,,	,,	,,	14.7	17.0	19.8
,,	,,	Average ..	15.4	—	—
,,	15.0	Individual..	18.6	15.1	18.5
,,	,,	,,	17.3	16.0	21.1
,,	,,	Average ..	18.0	16.2	20.1
450	7.5	Individual..	24.1	15.8	19.2
,,	,,	,,	24.1	15.9	18.6
,,	,,	Average ..	24.1	—	—
,,	15.0	Individual..	31.2	17.0	18.2
,,	,,	,,	27.3	15.6	20.2
,,	,,	Average ..	29.3	16.1	19.1
500	7.5	Individual..	37.0	15.1	17.9
,,	,,	,,	44.0	14.8	19.5
,,	,,	Average ..	40.5	—	—
,,	15.0	Individual..	49.4	15.0	19.2
,,	,,	,,	50.1	14.6	19.8
,,	,,	Average ..	49.7	14.9	19.1
550	7.5	Individual..	66.7	16.5	20.5
,,	,,	,,	67.1	15.9	19.8
,,	,,	Average ..	66.9	—	—
,,	15.0	Individual..	70.6	15.1	21.5
,,	,,	,,	71.6	14.3	19.8
,,	,,	Average ..	71.1	15.5	20.4
600	7.5	Individual..	81.5	16.0	21.1
,,	,,	,,	81.0	16.5	17.9
,,	,,	Average ..	81.3	—	—
,,	15.0	Individual..	84.4	14.8	19.2
,,	,,	,,	84.3	15.8	20.4
,,	,,	Average ..	84.4	15.3	19.7
650	7.5	Individual..	94.8	17.3	—
,,	,,	,,	94.4	15.4	19.9
,,	,,	Average ..	94.6	—	—
,,	15.0	Individual..	95.4	14.5	20.0
,,	,,	,,	95.6	15.2	21.7
,,	,,	Average ..	95.5	15.6	20.5

normal variations from test to test. but there is no regular change with increasing temperature of treatment. The results suggest that this particular material may be treated at 650 deg. C. for one hour without deterioration in mechanical properties. Examination of the microstructure failed to reveal any incipient spheroidisation of the pearlite. This finding is a little surprising, but it must be remembered that quite small additions of chromium, as in the present case, do retard spheroidisation at these temperatures, and it would not be safe to argue that an unalloyed iron of higher silicon content would not show deterioration in properties on stress-relief treatment at 650 deg. C.

Loded Centricast.—The results on this material are set out in Table III, and the stress-relief curves plotted in Fig. 3. In spite of its higher alloy content and generally increased stiffness at room temperature, the relief of stress in this material proceeds at almost exactly the same rate as in the softer sand-cast iron. Again, there is a tendency for greater percentage stress-

Stress Relief of Cast Iron

relief to be associated with higher initial stress, but the difference is even more slight than in the case of

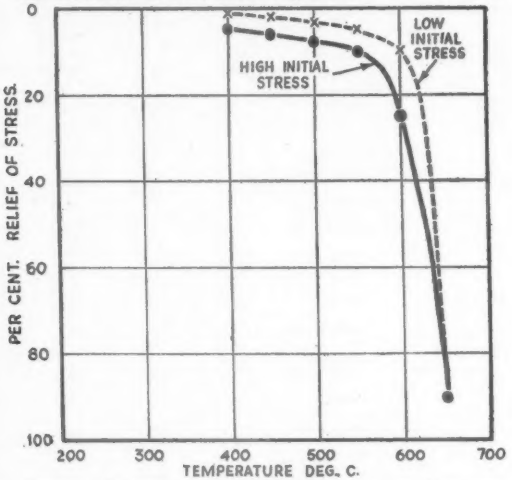


FIG. 4.—RELIEF OF STRESS ACCORDING TO TEMPERATURE FOR 33 PER CENT. CHROMIUM CAST IRON.

the sand-cast iron. Also, the mechanical properties show no regular change with temperature, and it

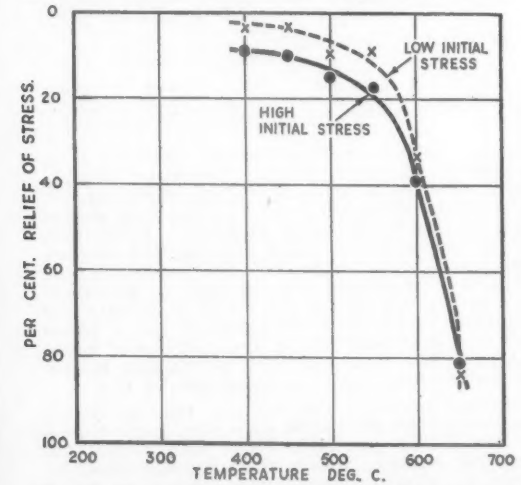


FIG. 5.—STRESS RELIEF ACCORDING TO TEMPERATURE FOR AUSTENITIC CAST IRON (NI-RESIST).

appears to be quite safe to subject this material to a stress-relief treatment at 650 deg. C.

Thirty-three per cent. Chromium Cast Iron.—Table IV and Fig. 4 present the results on this material.

TABLE III.—*Stress-relief Tests on Loded Centricast Material.*

Temp., deg. C.	Applied stress, tons per sq. in.	Result.	Per cent. stress relief.	En. × 10^6, lb. per sq. in.	Tensile strength, tons per sq. in.
300	15.0	Individual..	5.1	17.6	16.6
400	7.5	,,	10.8	17.9	17.2
,,	,,	,,	10.3	18.6	15.1
,,	,,	Average ..	10.6	—	—
,,	15.0	Individual..	10.8	19.2	16.0
,,	,,	,,	9.0	17.9	16.0
,,	,,	Average ..	9.9	18.4	16.1
450	7.5	Individual..	14.9	16.7	16.1
,,	,,	,,	15.5	17.2	15.8
,,	,,	Average ..	15.2	—	—
,,	15.0	Individual..	15.4	18.0	16.0
,,	,,	,,	16.2	16.8	15.4
,,	,,	Average ..	15.8	17.2	15.6
500	7.5	Individual..	32.5	17.9	16.6
,,	,,	,,	30.6	18.0	17.0
,,	,,	Average ..	31.6	—	—
,,	15.0	Individual..	34.2	17.8	16.0
,,	,,	,,	34.6	17.5	15.4
,,	,,	Average ..	34.4	17.8	16.3
550	7.5	Individual..	63.8	16.8	16.8
,,	,,	,,	61.7	18.3	16.6
,,	,,	Average ..	62.8	—	—
,,	15.0	Individual..	67.5	16.2	18.3
,,	,,	,,	66.7	16.3	17.2
,,	,,	Average ..	67.1	16.9	17.2
600	7.5	Individual..	83.1	17.7	17.5
,,	,,	,,	81.3	17.3	16.6
,,	,,	Average ..	82.2	—	—
,,	15.0	Individual..	85.4	16.4	17.2
,,	,,	,,	83.8	16.4	16.8
,,	,,	Average ..	84.6	16.9	17.0
650	7.5	Individual..	97.9	17.5	15.7
,,	,,	,,	98.3	18.2	15.0
,,	,,	Average ..	98.1	—	—
,,	15.0	Individual..	97.0	16.6	14.8
,,	,,	,,	96.2	16.6	16.7
,,	,,	Average ..	96.6	17.2	15.8

In the cold state, it is characterised by a much closer approach to Hook's law at moderate stresses than ordinary grey iron, and also by rather greater plasticity at high stresses. The stress-relief curves differ from those of the two previous materials, in that there is very little relief of stress at temperatures up to 600 deg. C., but very rapid stress-relief at higher temperatures, so that, as in the other irons, a treatment at 650 deg. C. would remove practically the whole of the internal stress. Once again, the higher the initial stress the greater the stress-relief, but the difference is more marked in this high-alloy material than in the lower-alloy irons.

The En values quoted in Table IV are very regular and the tensile strength values do not vary with temperature in a regular manner. There are considerable fluctuations in the individual tensile strength figures, but these are due to the unreliability of the ring form of test-piece in such relatively ductile materials. A

stress-relief treatment at 650 deg. C. is, therefore, suitable for 33 per cent. chromium cast iron.

Austenitic Cast Iron (*Ni-Resist*).—Austenitic cast iron at room temperatures behaves under stress like a grey iron, but has considerably increased ability to undergo plastic deformation. Its resistance to creep in the range 400 to 550 deg. C. is greater than that of low-alloy grey iron.[5] The stress-relief results shown on Table V and Fig. 5 are very similar to those on the

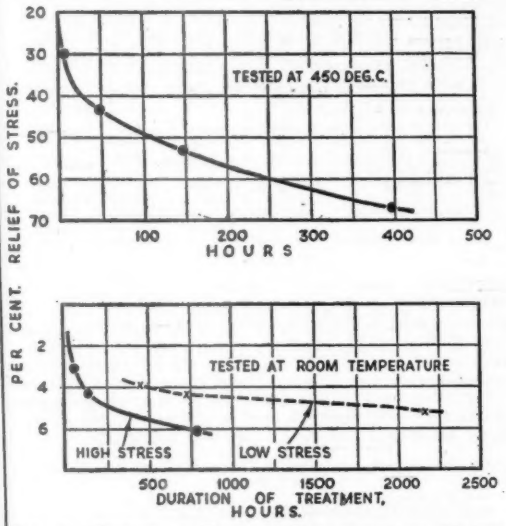


FIG. 6.—EFFECT OF TIME OF TREATMENT ON RELIEF OF STRESS IN STA/8 MATERIAL.

33 per cent. chromium cast iron and indicate less relief of stress at temperatures up to 600 deg. C. than in low-alloy iron, but a high degree of recovery at 650 deg. C. This behaviour is obviously connected with the creep characteristics of the material, though it must be remembered that, for the purpose of such tests as described in this Paper, only the stage of primary creep is concerned.

Unlike the other materials tested, the austenitic iron does appear to suffer a loss in tensile strength on heating above 600 deg. C., which is required for a substantial relief of stress. The En values remained constant, nor were any changes in microstructure or hardness noted during the stress-relieving operations. Austenitic cast irons are apt to suffer a transformation following long heating at intermediate temperatures, particularly if the austenite is of low-alloy content and thus of reduced stability. Although the Ni-Resist of satisfactory composition showed no breakdown in the main series of tests, it was considered advisable to extend the investigation to cover austenitic irons of lower alloy content. It was more convenient to do this on sand-cast material of a low phosphorus content.

TABLE IV.—*Stress-relief Tests on Centrifugally-cast 33 per cent. Chromium Cast Iron.*

Temp., deg. C.	Applied stress, tons per sq. in.	Result.	Per cent. stress relief.	En. × 10⁸, lb. per sq. in.	Tensile strength, tons per sq. in.
400	14.0	Individual..	1.4	31.3	44.0
,,	,,	,,	1.4	30.8	35.3
,,	,,	Average ..	1.4	—	—
,,	29.3	Individual..	5.1	30.6	38.6
,,	,,	,,	3.6	31.4	39.5
,,	,,	Average ..	4.4	31.0	39.4
450	14.0	Individual..	1.8	31.4	35.9
,,	,,	,,	2.3	31.6	41.7
,,	,,	Average ..	2.1	—	—
,,	29.3	Individual..	5.7	31.3	38.6
,,	,,	,,	5.9	31.1	47.0
,,	,,	Average ..	5.8	31.4	40.8
500	14.0	Individual..	3.2	31.3	46.4
,,	,,	,,	4.1	30.9	39.3
,,	,,	Average ..	3.6	—	—
,,	29.3	Individual..	8.1	31.4	38.7
,,	,,	,,	5.9	30.7	47.0
,,	,,	Average ..	7.6	31.1	42.9
550	14.0	Individual..	4.6	31.0	37.0
,,	,,	,,	4.6	31.3	42.4
,,	,,	Average ..	4.6	—	—
,,	29.3	Individual..	8.4	30.3	35.1
,,	,,	,,	11.0	30.8	37.9
,,	,,	Average ..	9.7	30.8	38.1
600	14.0	Individual..	10.5	31.5	37.6
,,	,,	,,	10.1	30.3	37.2
,,	,,	Average ..	10.3	—	—
,,	29.3	Individual..	25.0	30.6	61.0
,,	,,	,,	25.1	30.6	47.9
,,	,,	Average ..	25.1	30.7	45.9
650	14.0	Individual..	89.4	30.9	45.4
,,	,,	,,	91.2	30.6	37.4
,,	,,	Average ..	90.3	—	—
,,	29.3	Individual..	91.6	31.0	49.4
,,	,,	,,	91.2	30.5	42.8
,,	,,	Average ..	91.4	30.8	43.8

A series of four casts was made up, with progressive additions of nickel and copper, to an iron of otherwise normal Ni-Resist composition. The nickel contents ranged from 8.6 to 13.4 per cent. and the copper contents concurrently from 4.2 to 6.4 per cent. The specimens were treated for two hours at 550 and 650 deg. C., with results shown in Table VI. As in the first series, the Ni-Resist of normal composition showed relatively small stress-relief at 550 deg. C., but a high degree of stress-relief at 650 deg. C. The sand-cast material certainly did show more relief at 550 deg. C. than the centrifugally cast, but this may be partly accounted for by the longer time of treatment. Similar results were given by an iron with 12 per cent. of nickel and 5.5 per cent. of copper, but with 8.5 to 9.5 per cent. of nickel and 4.2 per cent. of copper, particularly at the lower alloy level, there was much greater apparent relief of stress at 550 deg. C. and rather more at 650 deg. C., than on the normal iron. The large amount of stress-relief at the lower alloy levels was accompanied by a substantial increase in hardness and by the development of relatively strong magnetic properties.

It is clear that in this case the result of heating to the stress-relief temperature was to cause partial inver-

Stress Relief of Cast Iron

sion of austenite, with a consequent expansion, which contributed appreciably to relieving the internal stress. it is interesting to note that, even with an alloy content as low as 9.6 per cent. of nickel and 4.2 per cent. of copper, there appears to be no breakdown of the austenite in 2 hrs. at 550 deg. C., while, with 12.0 per cent. of nickel and 5.5 per cent. of copper, there are only traces of breakdown after 2 hrs. at 650 deg. C. The much greater ductility of the low-phosphorus sand-cast Ni-Resist makes the ring test-piece for determination of mechanical properties inapplicable to this material.

TABLE V.—*Stress-relief Tests on Centrifugally-cast Ni-Resist Material.*

Temp., deg. C.	Applied stress, tons per sq. in.	Result.-	Per cent. stress, relief.	En. × 10⁶, lb. per sq. in.	Tensile strength, tons per sq. in.
400	7.75	Individual	2.8	17.3	16.4
,,	,,	,,	4.0	17.3	18.1
,,	,,	Average ..	3.4	—	—
,,	14.3	Individual..	9.8	16.7	18.1
,,	,,	,,	9.0	17.2	18.2
,,	,,	Average ..	9.4	17.1	17.7
450	7.75	Individual..	3.1	17.4	18.9
,,	,,	,,	4.1	17.0	18.0
,,	,,	Average ..	3.6	—	—
,,	14.3	Individual..	11.2	17.3	17.8
,,	,,	,,	8.6	17.9	19.8
,,	,,	Average ..	9.9	17.4	18.6
500	7.75	Individual..	10.5	17.5	19.5
,,	,,	,,	8.8	17.3	18.1
,,	,,	Average ..	9.7	—	—
,,	14.3	Individual..	13.7	17.9	19.3
,,	,,	,,	15.0	17.2	18.6
,,	,,	Average ..	14.3	17.5	18.9
550	7.75	Individual..	9.7	17.5	17.8
,,	,,	,,	8.3	17.9	19.4
,,	,,	Average ..	9.0	—	—
,,	14.3	Individual..	16.7	17.3	18.5
,,	,,	,,	15.9	16.3	16.5
,,	,,	Average ..	16.3	17.3	18.0
600	7.75	Individual..	33.6	17.4	17.4
,,	,,	,,	33.6	16.5	15.7
,,	,,	Average ..	33.6	—	—
,,	14.3	Individual..	39.2	16.9	17.0
,,	,,	,,	38.4	17.3	16.5
,,	,,	Average ..	38.8	17.0	16.7
650	7.75	Individual..	84.7	18.2	16.6
,,	,,	,,	84.5	17.4	14.9
,,	,,	Average ..	84.6	—	—
,,	14.3	Individual..	81.9	17.3	15.0
,,	,,	,,	81.7	16.7	14.5
,,	,,	Average ..	81.8	17.4	15.3

It may be concluded from these experiments that it is perfectly safe to subject Ni-Resist, with normal commercial variations in alloy contents, to stress-relieving treatments at 650 deg. C., though there may be some loss in tensile strength.

Effect of Duration of Stress-relief Treatment

The earlier work by Benson and Allison[3] showed that the longer the time at stress-relieving temperatures, the greater was the amount of stress-relief, though the difference between 1 hr. and 6 hrs. was not very great. More recently, Tottle has shown a remarkable effect with time, this effect extending down to room temperature. A certain amount of work was done on this question, both at 450 deg. C. and at room temperature, the results being shown in Table VII and Fig. 6. At 450 deg. C., prolonging the time of treatment to 400 hrs. leads to very substantial relief of stress, but at room

TABLE VI.—*Stress-relief Treatment of Sand-cast Ni-Resist Materials of Various Compositions.*

Composition :				
Ni, per cent.	8.64	9.59	12.10	13.36
Cu, per cent.	4.19	4.23	5.51	6.39
Per cent. Stress Relief after				
2 hours at 550 deg. C. ..	85.0	44.8	37.4	37.8
2 hours at 650 deg. C. ..	100.0	86.6	83.4	81.8
Vickers Diamond Hardness				
Before treatment ..	248	159	137	130
After 2 hrs. at 550 deg. C.	354	154	139	135
After 2 hrs. at 650 deg. C.	366	241	156	130
Degree of Magnetism				
Before treatment ..	Slight	Very Slight	Very Slight	Very Slight
After 2 hrs. at 550 deg. C.	Medium	Very Slight	Very Slight	Very Slight
After 2 hrs. a 650 deg. C.	Strong	Medium	Slight	Very Slight

temperature at either stress, treatments extending to three months do not appear to make a really useful contribution. The order of stress relief at room temperature is the same as that reported by Tottle under conditions of steady stress,[2] and the conclusion from the present work is that the practice of stress-relieving castings by weathering is not nearly as reliable as by using short-time heating at elevated temperatures.

TABLE VII.—*Effect of Duration of Treatment on Relief of Stress in STA/8 Material.*

Temp. of treatment.	Applied stress, tons per sq. in.	Duration of treatment.	Percentage relief of stress.
450 deg. C.	15.0	5 hours	29.5
,,	15.0	48 ,,	43.7
,,	15.0	144 ,,	52.8
,,	15.0	398 ,,	67.3
Room	15.0	50 hours	3.2
,,	15.0	160 ,,	4.3
,,	15.0	788 ,,	6.2
,,	15.0	788 ,,	6.2
Room	7.5	450 hours	3.9
,,	7.5	791 ,,	4.3
,,	7.5	2,168 ,,	5.2

Conclusions

(1) In comparatively low-alloy, sand-cast or centrifugally cast iron, over 80 per cent. relief of stress may be attained by heating to a temperature of 600 deg. C. for 1 hr. This is not accompanied by any deterioration in mechanical properties or in microstructure.

(2) In high-alloy iron of the 33 per cent. chromium and Ni-Resist class, it is necessary to heat to 650 deg. C. to obtain a satisfactory degree of stress relief. This does not affect the mechanical properties of the 33 per cent. chromium iron, but may reduce the tensile strength of Ni-Resist by about 10 per cent.

(3) The magnitude of the initial stress does not have a predominating effect on the relief of stress at any given temperature but in all four materials there is a tendency for the percentage relief of stress to be higher with a higher initial stress. This is particularly marked in the high-alloy irons at moderate and low temperatures.

(4) Prolonging the time of treatment at 450 deg. C. greatly increases the amount of stress relief, but the rate is prohibitively slow.

(5) Ageing at room temperature for several months appears to lead to a maximum relief of stress of about 10 per cent. The practice of stress relief by heating to an elevated temperature is, therefore, greatly to be preferred to the practice of weathering at atmospheric temperature.

Acknowledgment

The work described in this Paper was carried out in the laboratories of the Sheepbridge Stokes Centrifugal Castings Company, Limited, and the Authors wish to express their thanks to the Board of the Company for permission to publish the results.

REFERENCES

1 Report of Sub-Committee T.S.17. *Proceedings*, Institute of British Foundrymen, 1946/47, Vol. 40, p. B 41. See also Institute of Metals, Monograph and Report Series No. 5, 1947, p. 179.
2 C. R. Tottle, *Proceedings*, Institute of British Foundrymen, 1947/48 Vol. 41 p. A67.
3 L. E. Benson and H. Allison, *Proceedings*, Institute of British Foundrymen, 1937/38, Vol. 31, p. 124.
4 L. E. Benson and H. Allison, Iron and Steel Institute Welding Symposium, 1935.
5 H. J. Tapsell, M. L. Becker and C. G. Conway, *Journal of the Iron and Steel Institute*, 1936, No. 1, Vol. 133, p. 303.

Publications Received

Inconel and **Monel and K Monel.** Published by Henry Wiggin & Company, Limited, Birmingham, 16.

These two publications include notes on the corrosion-resistant qualities under various conditions, tables on physical constants, mechanical properties and effects of temperature. Both booklets should be of interest to mechanical and chemical engineers.

Foseco. Published by Foundry Services, Limited, Long Acre, Nechells, Birmingham, 7.

This brochure has for its objective the expounding to its readers of the facilities the publishers possess for giving a specialised service to the foundry industry. This has been done by the use of copious illustration, designed to show the factories, shops, laboratories and their equipment, together with examples from practice of results achieved. The letterpress enlarges on the illustrations and in addition includes a list of the products made. Effective use has been made of colour printing, the dominant shades being bright blue and orange. The brochure, which runs to 16 pages, is available to our readers on application to Nechells.

Book Reviews

Conference on the Non-Destructive Testing of Steel Castings. Published by the British Iron and Steel Research Association, 11, Park Lane, London, W.1. Price 10s.

Running to 68 well-illustrated pages, this Report covers by means of short Papers and discussions such subjects as X-ray, gamma ray, magnetic and ultrasonic testing. The real value of such a Report is the assembling in one book, information which is widely scattered; yet a selected list of references would have increased its great usefulness.

V. C. F.

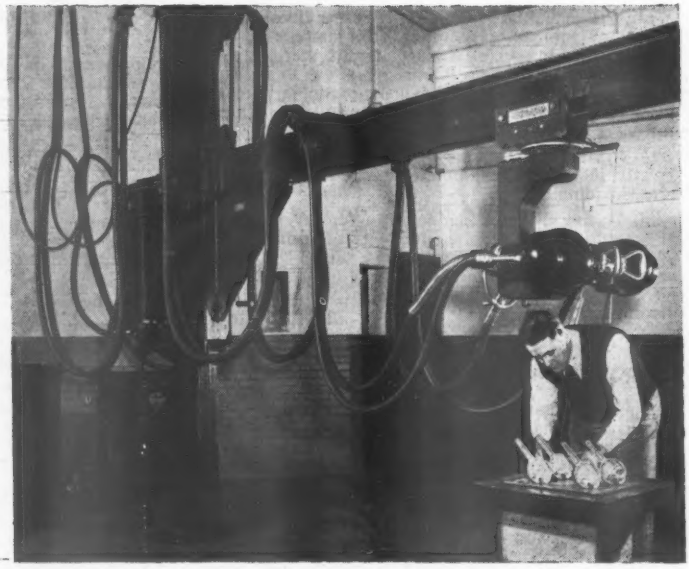
Light-alloy Foundries in Germany. B.I.O.S. Final Report No. 1861. Published by H.M. Stationery Office, Kingsway, London, W.C.2. Price 20s. net.

The more the reviewer reads of these reports on German industrial plant the more he is convinced that the majority of teams "missed the boat." They only seemed interested in what the works did during the war, and not what they made before the war and where their products went to, and why. This particular report, written in 1945, is particularly detailed, yet much of it is, by now, like last year's cricket annual. There are the statistics pertaining to an obvious transition period, and to the wartime maxima. The types of alloys used, the nature of the moulding sands, the sort and capacity of melting plant installed are given in meticulous detail, yet it is to-day dreary reading. The current interest is the competitive position of these works, which are now quite different from their semi-derelict aspect of 1945. If one of the experts could boil down the report, which covers about 200 pages, and stress any points of outstanding interest or major differences from British practice to-day, he would be doing a good service, for wading through the book is at this juncture quite tedious.

V. C. F.

New Catalogue

Forehearths. A leaflet (No. 55.A.) received from Birlec, Limited, Tyburn Road, Erdington, Birmingham, 24, describes and illustrates the Birlec-Lectromelt forehearth suitable for attachment to existing cupolas. Though somewhat on the lines of an electric melting furnace, the forehearth is simpler both with regard to electrical gear and operating mechanism. Moreover, the electrical input capacity is, naturally, smaller in relation to the metal capacity. The unit, which is made in a range of sizes, is said to be suitable for use as a holding furnace and for duplexing cupola metal with cold alloys. If circumstances demand, the equipment can be remote from the cupola, in which case molten metal is brought by ladle for superheating, duplexing or holding as required. Copies of the leaflet may be obtained by our readers on application to the Birlec Publicity Department at Erdington.



Jib-crane-mounted X-ray machine manufactured by the Westinghouse X-ray Division and shown in use at the Company's own foundry. It is suitable for sections up to 4 in. thick.

International Foundry Congress

Papers for Presentation

The following Papers are to be presented at the International Foundry Congress, which is being held in Amsterdam from August 29 to September 3:—

"Some Heat-transfer Problems Simplified," by Mr. J. S. Abcouwer (Netherlands); "Twenty-five Years' Progress in the Evolution of Cast Iron," by Mr. M. Ballay and Mr. R. Chavy (France); "The Manufacture of Ingot Moulds in Cement Sand," by Mr. J. P. J. Bruschke (Netherlands); "Developments in Blast Furnace Efficiency," by Mr. T. P. Colclough (England); "Foundry Melting Furnaces for Copper and Nickel-base Alloys," by Mr. F. C. Evans (England); "Magnesium (Elektron) Casting Alloys—Engineering Properties and Foundry Technique," by Mr. L. J. G. van Ewijk (Netherlands); "Influence of Oxygen, Nitrogen and Carbon on the Impact Strength of Iron and Steel," by Mr. D. J. Fast (Netherlands); "A Special Case of Carbon Diffusion: from Cast Iron to Cast-in Steel," by Mr. J. E. de Graaf (Netherlands); "Ferrous Melting Furnaces in the United States and Canada," by Mr. A. W. Gregg (U.S.A.); "Sand-preparing Plant," by Mr. R. Grimault (France); "Car-engine Piston Ring Cast Centrifugally in the Form of Sleeves," by Mr. P. Januszewicz (Poland); "A Special Die-casting Method," by Mr. E. M. H. Lips; "Experimental Equilibrium Tests and the Preheating of a 36-in. Cupola," by Mr. P. G. Maceraudi (Italy); "Material-handling in Jobbing Foundries," by Mr. J. J. Manders and Mr. H. R. Bruce (Netherlands); "Non-destructive Testing of Castings," by L. v. Ouwerkerk (Netherlands); "Preparation of Moulding Sands," by Mr. L. Petrzela (Czeckoslovakia); "Modern Work Organisation in the Foundry," by Mr. D. J. da Silva and Mr. J. J. Verzijl (Netherlands); "Contribution to Standardisation of Test Methods for Moulding Sand," by Mr. M. Stap (Netherlands); "Some Metallurgical and Practical Aspects on the Melting of Copper Alloys," by Mr. A. Swagerman and Mr. H. Leutscher (Netherlands); "Some Belgian Research Results on Nodular Cast Iron," by Mr. A. L. de Sy (Belgium); "Correlation between Different Hardness Numbers for Grey Cast Iron," by Mr. J. Wozniacki (Poland); "The Manufacture of Metal Patterns and Core Boxes without Machining by the Clay-plaster Method," by Mr. J. van Yperen (Netherlands); "The Temperature of Liquid Steel in Relation to Fluidity and 'Burning-on' in Steel Castings," by Mr. A. J. Zuithoff (Netherlands).

A. C. WICKMAN, LIMITED, announce the appointment of Mr. C. F. Watts as secretary to the company, and of Mr. W. V. Hodgson, as general manager, Machine Tool Division. Mr. Watts, who succeeds the late Mr. F. O. Hughes, joined the company in 1945 as deputy to the financial director. Mr. Hodgson joined the firm in February, 1947, and until the present appointment was the company's chief sales engineer.

Centrifugal Casting of Bronze

Worm-gear Development

This year is an interesting anniversary in the vertical-axis centrifugal casting of phosphor bronze, in that it is 25 years since David Brown & Sons (Huddersfield), Limited, put this process on a commercial basis. Earlier stages of worm-gear development were, first, the special thread which was patented in 1913 and which revolutionised the application of worm gears. Another stage, which was developed parallel with the worm thread, was the creation of specialised worm-gear plant for their efficient and accurate production.

The next stage, which is the subject of this anniversary, was the development of a bronze which would substantially increase the life of worm gears from that achieved up till then by chilled sand castings. Chilled castings, whilst not by any means unsuccessful, had the disadvantage of having the denser metal at the periphery with a gradual deterioration of structure towards the roots of the teeth, and as wormwheel teeth are of substantial proportions, this meant that the worst metal was at the most highly stressed point, in addition to which the flanks of the teeth were not of homogeneous structure throughout their depth. As the tooth depth was a substantial proportion of the rim thickness, excessive chilling could only be carried out at some sacrifice in the tensile strength.

It was realised that centrifugal casting was the solution, as it would permit the fine dispersal of an optimum tin content which predisposed the best wear-resisting conditions, whilst this method would also help to give uniform density.

It is not proposed to go into all the vicissitudes of the five years of experimenting covering the investigation, as the main purpose of this article is to mark an interesting occasion, but when all the technical requirements had been satisfied, no time was lost in putting the process into commercial use.

FIG. 1.—WORM GEARS FROM AN ALBION 50-CWT. LORRY AFTER 413,000 MILES' SERVICE.

The success of the project was obvious when it was found possible to cast, in addition to plain annular rings, all the varied shapes that were then in production by other means, including those where the bosses round the differential-cage bolts were shrouded on each side. The flexibility of the process encouraged experiment in the rough casting of the teeth by the use of segmental moulds round the periphery, and even this

FIG. 2.—GENERAL VIEW OF THE CENTRIFUGAL BRONZE FOUNDRY.

Centrifugal Casting of Bronze

complication presented no founding difficulties, although the method was not pursued, as it was more than counterbalanced by extra wear on the hobs and slight inaccuracies in the finished products, which was introduced due to the slight variation in the amount of metal to be removed by the hobs.

Everyday Job

The process has since then become an everyday job at the Penistone foundries of the David Brown Foundries Company, and Fig. 1 illustrates the standard which has been reached in that it depicts a bronze wormwheel and steel worm which were taken from the rear axle of a 50-cwt. Albion lorry after 413,000 miles strenuous usage, mainly among the hilly districts of Yorkshire and Lancashire. It will be seen that the condition of the wormwheel is such that it could be replaced for further duty with every confidence in many more thousands of miles of efficient service. Fig. 2 shows a general view of the centrifugal bronze foundry with individual clutch control levers for each spinning machine; reverberatory furnaces are shown on the right-hand side.

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained. Details of tenders with the reference E.P.D. or C.R.E. can be obtained from the Commercial Relations and Exports Department, Board of Trade, Thames House North, Millbank, London, S.W.1.

FYLDE, August 23—Supply of manhole covers, etc., for the Water Board. Mr. H. W. Apted, engineer, Sefton Street, Blackpool.

MOUNTAIN ASH, August 27—Supply of 6,300 yds. of 4-in., 500 yds. of 3-in. dia. cast-iron pipes, etc., Class "C," for the Urban District Council. The Engineer and Surveyor, Town Hall, Mountain Ash.

BLACKBURN, August 13—Supply and laying of approx. 8,100 yds. of 3-in., 4-in. and 6-in. spun cast-iron water mains, etc., for the Rural District Council. Mr. A. Brooksbank, consulting engineer, 14, The Exchange, Bradford. (Deposit, £2 2s.)

CORK—Supply of 800 yds. of 4-in. cast-iron pipes, etc., for the County Council. Mr. E. Callanan, secretary, Council Offices, District Hospital, Mallow.

MALAYA, August 15—Malleable cast-iron pipe fittings, for the Singapore Municipality. (Reference: C.R.E.(I.B.) 19534/49; Room 1075.)

SWAFFHAM, August 22—Supply of approx. 1,950 yds. of 4-in. dia. spun-iron water mains, for the Rural District Council. W. Herbert Bateman & Partners, consulting engineers, Halifax House, Bank Plain, Norwich. (Deposit, £2 2s.)

ACCORDING TO THE "Iron Age," a parabolic radar antenna 50-ft. dia., is to be built for the American navy from 28 cast-aluminium sections each weighing a ton. After assembly, the antenna will be machined as one unit. Patterns are scheduled for completion in September and delivery of the finished unit is expected before the end of 1950.

Existing Government Control

The Supplies and Services Acts, 1945 and 1947 (down to expire December 10, 1950) are those which give power to the Government to exercise control over industry, and individuals for that matter. Therefore it is thought of interest to show how this power can be or is exercised, especially as, in certain circumstances, the Acts may be renewed.

The general power is for maintaining, controlling and regulating supplies and services and this power is exercised by certain Orders in Council which have been introduced and which are founded on the Defence (General) Regulations, 1939, with other Regulations *e.g.*, Defence (Encouragement of Exports, 1940; Defence (Finance) Regulations, etc.), but it should be noted that only these Regulations can be continued by these Acts. These are quite sufficient, however, to give the Government complete control, if it so desires, as the Orders in Council cover practically everything relating to trade and industry (there are 138 such Regulations). The powers extend to the direction of labour, the taking over of shares of companies as regards individual concerns, etc., although there is no power in these Acts to nationalise whole industries and so forth.

What should be particularly noted by industry generally and by the individual, too, are the powers of control contained in Part IV of the Defence Regulations retained and operating by the Orders in Council mentioned. In this Part IV, power is given to regulate or prohibit the production, treatment, keeping, storage, movement, transport, distribution, disposal, acquisition, use or consumption of articles of any description. Road and rail matters, agricultural affairs, requisitioning, etc., also come under Part IV. Part III concerns shops, aircraft and the like. By the foregoing regulations such things as limitation of supplies, licensing, rationing of production or raw materials, and so forth are covered, as are also the coupons and points systems.

Forty Years Ago

The August, 1909, issue of the JOURNAL prints an account of the Annual Convention of the British Foundrymen's Association (now the Institute of British Foundrymen), which was held in Birmingham; Mr. F. J. Cook presided. The membership was 448, and the subscriptions were for an "honorary" member 10s. 6d.; for an ordinary member 7s. 6d, and for a branch associate 3s. However, it was mooted to raise subscriptions to a guinea for members, half a guinea for associate members, and 3s. for associates. Amongst those participating in the congress were Dr. Longmuir and Mr. Charles Jones, vice-presidents, and Mr. H. Winterton, Mr. H. L. Reason, Mr. V. C. Faulkner, and Mr. S. A. Gimson, all of whom were later destined to be president of the Association. Other well-known people present were Mr. V. Jobson, Mr. W. B. Parker, and Mr. R. Mason (now in Australia).

This issue carries a full account of the centenary celebration of the Friendly Society of Ironfounders, at which Mr. Arthur Henderson, M.P., was the chief speaker.

Influence of Heating Rate in Malleable Iron Annealing*

Discussion Consolidates a Valuable Research

Results from Slow Heating

Opening the discussion, MR. H. G. HALL, president of the Birmingham Branch of the Institute, said Mr. Palmer had begun his remarks by stating that the normal method of annealing in this country was the use of large furnaces of massive design containing large quantities of material, and from that angle the Paper appeared to be of little use, but he thought it worth pointing out at that stage that research work done on malleable cast iron was at least 10 years ahead of its application. The Paper was yet another example of a series of experiments which had been proceeding for the last 10 years. Such experiments provided the information which would enable the technicians of the industry to insist on and, ultimately, to obtain those modern furnaces which would enable them to turn out a much more uniform product. It was rather interesting that the Americans, almost simultaneously, had done some work on the same theme and had arrived at very similar conclusions. The only point on which he thought they differed was that they were inclined to minimise to some extent the importance of rate of heating-up *per se*. He thought Mr. Palmer had made it perfectly clear that that rate was important, but in his opinion he had not emphasised it sufficiently; nor had he carried the matter to its logical conclusion. They were not informed by the Paper whether there was any actual saving in total time of annealing. That was another step to be investigated.

Effect of Section

It seemed obvious to him that if one was making thin-section whiteheart malleable, then there was little point in a slow rate of heating, but when making heavy-section whiteheart, although there was apparently very little improvement in the physical properties, as quoted in the Paper, a most important point was that there was very little eutectic cementite in the bars which had a slow rate of heating. With the large-type furnace, which they normally used, he believed the normal slow rate of heating was in itself a safety factor.

The heating rate of blackheart malleable, he thought, was rather interesting and brought out a unique feature. That in the slow rate of heating, not only did the elongation increase materially, but the tensile strength was very much improved. That was worth emphasis. One other point, which Mr. Palmer did not emphasise, was an observation which had yet to be established by further experiment; it was that the physical test results on the test-bars cast in green-sand moulds were considerably inferior to those of bars cast in dry sand or sand of high permeability.

A final point, which really bore on Mr. Hallett's Paper,† was that Mr. Palmer was very careful not to draw any conclusions as to the reasons for the improved properties of the bars subjected to a slow rate of heating. But there had been many references in literature to the fact that a slow heating rate, in some way, affected the amount of hydrogen present in the material and that by some sequence of events the final nodular structure was affected. Mr. Palmer's experiments indicated that, in a material containing excess hydrogen, the response to the low-temperature treatment was extraordinarily rapid. He had been impressed, when listening to Mr. Hallett's Paper, by a similar range of heat-treatment and wondered if there was any tie-up possible between the gas content of the iron and the amount of stress therein. It might be interesting to see whether, with a deliberately-introduced hydrogen content, there was a different measure of stress-relief response.

Influence of Modern Equipment

MR. PALMER, replying, said that most of the malleable-iron manufacturers in this country employed the pack-annealing process, *i.e.*, with the castings protected and at the same time unavoidably insulated during annealing by a suitable packing material and the whole contained in annealing pots. The fact that the castings were thermally insulated in the pack-annealing process, coupled with annealing furnace design, enabled only a relatively slow rate of heating to annealing temperature to be attained. On the other hand, recent developments had made available types of electrically heated annealing furnaces using controlled gaseous atmospheres, which dispense with the need for packing material and enable very much more rapid rates of heating to be employed. It was intended that his Paper should contribute some of the information required by a malleable-iron manufacturer when considering the installation of new annealing equipment.

The Paper had shown that the occurrence of numerous small temper carbon nodules in malleable iron bestowed certain benefits on the material, especially in the case of blackheart iron, and that the desired temper carbon distribution could be obtained by using a slow rate of heating to the annealing temperature. Additional experiments reported in the Paper indicated that, when using an annealing furnace capable of a rapid heating rate, then a slow heating treatment through a limited temperature range, or a preheating treatment within this range, would probably give the desired temper-carbon distribution in a very much shorter time than the slow heating period used in the present work. Thus, for example, a furnace might heat up from room temperature to 400 deg. C. in two or three hours, then slow heat from 400 to 600 deg. C. in 10 hrs., and thereafter rapidly heat to the annealing temperature in, say, four hours, ultimately to produce annealed material having the desired temper-carbon-nodule dis-

*A Paper, by Mr. S. W. Palmer, presented at the Annual Conference of the Institute of British Foundrymen, and published in our issues for July 28 and August 4.

†Printed on page 177.

Malleable Iron Annealing—Discussion

tribution in its structure. As Mr. Hall pointed out, manufacturers had to decide whether the extra 10 hrs. spent in heating up led to subsequent saving in first-stage and second-stage annealing time sufficient in amount to justify its inclusion. It was admitted at the end of the Paper that further work on this point was necessary.

He agreed with Mr. Hall that heating rate was of little importance in the annealing of thin-section whiteheart, but was of considerable importance when considering the complete removal of eutectic cementite from thick-section whiteheart. It was, indeed, of interest that, in the case of blackheart material, the tensile strength and elongation improved together as a result of an increase in nodule number. An increase in the number of nodules led to the reduction or the elimination of pearlite from the matrix. One would expect decreasing tensile strength with decreasing pearlite in the matrix, but the reverse was the case. It might be that the form of the graphite was responsible for this effect, and that numerous small compact nodules in blackheart iron gave better tensile strengths than did large dispersed aggregates of temper carbon.

The mechanical test results and microstructures of the melts poured in various mould conditions were included in the Paper only to illustrate that, if some factor, perhaps unknown, was causing poor annealability and incomplete second-stage graphitisation, then, by adjustment of heating rate to obtain the desirable temper carbon distribution, these factors (such as the apparent influence of wet sand) might be restricted in their effect.

The CHAIRMAN (Mr. Sheehan) mentioned that he had received a written contribution from Mr. A. E. Peace.

Following a request from the body of the hall, the Chairman read out Mr. Peace's contribution.

MR. A. E. PEACE wrote that the effect of heating rate upon the time taken to anneal malleable cast iron had been investigated in the past for blackheart malleable cast iron, but this was the first publication dealing with whiteheart. As the Author pointed out, the matter had become of greater interest to-day because of changes in furnace design and operating methods for the process. Although it might not be the only phenomenon caused by varying the heating rate, the change in the number of graphite nodules was undoubtedly the pre-eminent factor in determining the time for annealing. It appeared that the rate of graphitisation was governed, for the most part, by the migration of carbon to graphite nuclei. Therefore, where there were few nuclei, the distance through which the carbon had to migrate was greater than when there were many nuclei.

Early Evidence

Early evidence of this phenomenon was contained in publications by White and Schneiderwind,[4, 5] who showed the effect of silicon content and of degree of superheat on the rate of graphitisation. However, whilst the metallographical evidence showed changes in the number of graphite nodules, the investigators at the time did not give much attention to this aspect. The nodule counts given in the present Paper were linear, and it should be pointed out that the relation of one count to another, whilst showing in many cases remarkable differences, was not a reflection of the true relationship. It would be desirable to convert the linear counts into figures per unit volume. It was impossible to do this with accuracy, but an approximate method was published by Schwartz[7] in 1936.

Reference was made on page 4 of the Preprint (and subsequently) to secondary graphitisation. Mr. Peace suggested that the term "second stage" be used. This would enable distinction to be made between primary graphitisation, that was graphitisation taking place during solidification in the mould, and secondary graphitisation, being graphitisation in the solid during the annealing process. This secondary graphitisation, then, would cover "first stage" and "second stage" graphitisation of the annealing treatment, the former being the graphitisation which took place at the holding or annealing temperature and the latter being graphitisation which took place on cooling to, or holding at, the critical.

The danger of the persistence of eutectic cementite in whiteheart malleable mentioned on page 17 of the Preprint required emphasis, and particular attention should be given to the probability of hyper-eutectoid cementite being retained as a fine network. Reference to the latter was made on page 5 of the Preprint. This particular structure had a profound embrittling effect, although it was hardly detectable by measurement of elongation. It was also apt to escape diagnosis, as it did not greatly affect the appearance of the fracture and, indeed, was not always revealed by the microscope unless the etching technique was excellent and the observation critical.

Effect of Sulphur/Manganese Ratio

The Author was to be congratulated upon the excellent representation in the diagram of Fig. 17. The effect of the sulphur/manganese ratio upon the results of varying nodule count in whiteheart malleable was splendidly demonstrated. A further and extremely valuable and novel disclosure was the establishment of a temperature range, 400 to 600 deg. C., over which the slow heating rate was most effective. The Author drew attention to the probability of 400 deg. C. being most critical. The writer recommended that work be continued to establish the most effective temperature or temperature range with greater precision, and would draw attention to the possibility of relating this particular range of temperature with other phenomena. It was interesting to recall that the critical temperature in the cooling of blackheart malleable which was effective in cases of white ferrite embrittlement was around 450 deg. C. and, furthermore, that this phenomenon was associated in some way with silicon.

A further extension of the work, particularly in blackheart malleable, was desirable, to relate first the actual time required to obtain equilibrium at the annealing temperature and, second, the time at the critical for complete graphitisation to the nodule count and the time occupied by the particular slow-heating rate. It was well, also, in investigations of this nature to pay

(*Continued on page* 195.)

Measurement of Productivity and Efficiency*

By J. Close

The subject of this Paper outlines a problem which, at the present time, is particularly important to everybody in industry and, indeed, to the whole nation in view of the efforts Britain and other European countries are making to effect complete recovery before the end of Marshall aid. The Anglo-American Productivity Council created five separate committees, each to study a particular problem, one of which was the measurement of productivity or efficiency. It is realised that this particular committee was concerned with the comparison as between British and American industries, but, before this can be achieved, measurement of industries in this country must come first, and it is the measurement of productivity in the ironfounding industry which it is proposed to discuss.

The Council will deal with international economic problems, but foundrymen are only concerned with their own shops, and when the existing sellers' market is satiated the home manufacturers will be faced with fierce competition for world markets. This will be particularly true for manufacturers of engineering products faced with competition from American mass-production plants, whose productivity is *more than twice* that of this country.

How to increase productivity is outside the scope of this Paper, but the significance of "productivity per man" will be generally recognised, and it is an urgent problem for the industry to find a suitable yardstick with which to measure it, for the following reasons.

To meet the impending competition it is essential for industries, particularly the basic ones, to produce at the very highest level of efficiency not only when this competition is evident but immediately to ensure that British products are on sale in the world's markets at reasonable rates which are not related to scarcity values. The problem is, therefore, the production of a suitable set of standards by which each manufacturing unit in the industry may be measured and the inefficiencies of all or any may be brought to light and eliminated.

Difficulties of Assessment

To the outsider, it would seem that the ironfounding industry has a simple straightforward measure, in tons of good castings produced per man. This would be true if all foundries were producing similar types of castings, but this is very far from being the case, and the output per man in a foundry producing light, complicated castings would not be a fair comparison with the output per man in a foundry producing simple, heavy castings. This is a major difficulty in the way of using weight of output as a measuring factor, particularly as no *two* foundries have an identical classification of output.

A second difficulty is the fact that some of the larger units spend many thousands of pounds of capital to provide mechanical aids for manufacture. By mechanical aids is meant equipment provided over and above the essential plant every foundry must have, such as cupolas and the like; mechanical aids being equipment planned to replace hand labour in sand handling, machine moulding, etc. As is easy to visualise, a foundry provided with modern mechanical sand-handling equipment, etc., will have a much higher output per man than one which does not provide these aids to production.

Thirdly, the grade of the metal mixtures used will have an effect on output, though this is probably not easily apparent. Alloys, high-duty irons and the higher-grade mixtures need a bigger control staff, both at the cupola and in the stores, than the lower-grade irons.

Capital Expenditure Equivalents

To overcome the first two of these difficulties it has been suggested that an equation should be devised where the expenditure of a certain capital sum should represent the addition of one employee in arriving at the output per man. This capital sum to be arrived at by calculating the amount which would cost the same in depreciation, maintenance, power and insurance etc., as one man would in wages, insurance and services such as heat, light and canteens. When this amount is decided upon, the total capital outlay involved in providing mechanical aids would be divided by that amount, and the answer would be the equivalent number of men that the plant represents. To give an example, let it be assumed that the amount of capital reckoned to be equivalent to one man is £1,500. Then a foundry employing 100 actual employees with plant valued at £25,000 and an output of 1,000 tons per annum would have an *actual* output per man per annum of 10 tons. If, however, the plant equivalent (which is £25,000 divided by £1,500) be added, the total becomes 117, and the output per man 8½ tons per annum, the latter figure would then be more nearly comparable with a foundry employing only hand labour.

A serious obstacle, however, to such a method is the fact that the mechanical aids are not all of the same age, and it is obviously unfair to compare the cost of pre-war equipment with the cost of post-war equipment, and replacement values of some plant would be difficult to arrive at.

To compensate for the third difficulty of the class of iron-mixture varying with the use to which the cast-

*Entry for a Short Paper Competition organised by the East Midlands Branch of the Institute of British Foundrymen.

Productivity and Efficiency

ing is to be put, the annual sales figure could be used to provide a balancing factor between heavy castings made of lower-grade irons, and light complicated castings made with high-grade irons.

To appreciate the complexity of this question, it should be realised that there are about 1,760 iron-foundries in this country, of which only about 135, less than 8 per cent., employ 200 or more operatives, while roughly 40 per cent. of the total number of foundries employ fewer than 25 operatives.

The obvious solution to the problem is the comparison of costs between manufacturing units, but if 40 per cent. of the entire industry is comprised of foundries employing fewer than 25 operatives, it is probable that this large percentage will not be using modern costing methods. Costs can only be used for comparisons between any two or more concerns in an industry when they are prepared on the same basic principles and from the same class of data so that like is being compared with like.

The Council of Ironfoundry Associations has published a booklet on "Cost Ascertainment" methods based on uniform principles and its adoption by the industry as a whole would facilitate the production of comparative data which would be of value to the industry, and to individual members in particular. It would enable members to check their efforts compared with those of others and see if their results were as good as the best in the industry, or if not it would point the way to where improvements would be of benefit.

When this Paper was prepared the writer had at the back of his mind the idea that it would provoke members to a good deal of discussion, as it is of little value as a subject as it stands. If, however, joint efforts can produce some fresh ideas on this very topical subject it is felt that they will not have been in vain.

Scottish Industries Exhibition

More than 300 manufacturers have taken space at the Scottish Industries Exhibition, which will be held in Kelvin Hall, Glasgow (the largest hall in Scotland), from September 1 to 17. It will be open daily, except on Sundays, from 10 a.m. to 10 p.m., the morning period being recommended for trade buyers. It is interesting to find foundry concerns figuring prominently among the exhibitors; the list includes the following well-known names:—

Renfrew Foundries, Limited, Hillington, Glasgow; Federated Foundries, Limited (Grangemouth Iron Company, Limited), Camelon, Falkirk; Mitchell, Russell & Company, Limited, Bonnybridge; Smith & Wellstood, Limited, Bonnybridge; Allan Ure & Company, Limited, Glasgow; Walker, Hunter & Company, Limited, Falkirk; Urquhart Lindsay & Robertson Orchar, Limited, Dundee; Colvilles, Limited (representing the Colville Group), Glasgow.

Arrangements are being made for overseas buyers especially to visit factories and works to see actual production and to confer with managements—a worthwhile extension of the usual exhibition facilities.

Hooks or Soldiers

By "Tramp"

To support the top part of a mould, a certain amount of reinforcement of the sand is necessary. This is often accomplished by the cross-bars or binders on the top box. When, however, the top has to carry a pod or cod of sand, some other method is desirable. For dry sand moulds, hooks either of wrought iron or cast iron hung from the bars in the top box are often used, or alternatively, a cast-iron grid can be suspended from the box.

For green sand moulds, hooks are not so suitable as are wooden "soldiers," as the former are invariably coated with a slurry mixture to assist the sand to adhere to them. This slurry, being on the damp side, occasionally seeps through on to the face of the green sand mould and results in a waster due to blowing.

This defect has been noticed chiefly in shops doing both dry and green sand work, the greater proportion being of the former type, consequently a considerable number of hooks were in existence. If wooden "soldiers"—pieces of wood soaked in water overnight—are rammed up in the pod of a green sand job, they are sufficient to effect a clean lift and hold the sand together without the risk of the type waster associated with the use of hooks.

New Research Laboratories in Scotland

On the stand of the Department of Scientific and Industrial Research at the Scottish Industries Exhibition, there will be a model of the Department's new laboratories shortly to be opened in Scotland. This is the Technical Engineering Research Station which is being built at Thorntonhall, East Kilbride, for study into a wide variety of mechanical engineering problems, including lubrication and machining.

Beryllium Hazards

A recent issue of the Bulletin of the British Cast Iron Research Association reports on the incidence of industrial hazards with beryllium and beryllium compounds and quotes from current literature, which reviews the dangers of pneumonitis from these sources.

While beryllium and its compounds are not normally used in the average foundry laboratory or works laboratory, they may find increasing applications in specialised works for refractories, in non-ferrous alloys, or in vitreous enamels.

IT IS REPORTED in the "Iron Age" that the conveyor-belt market, recently invaded by stainless and high-strength, low-alloy steels, has another aspirant. Vitreous-enamelled conveyor-belt slats are said to have given good service under corrosive and moderately-high-temperature conditions.

The Export Guarantees Act, 1949

New Provisions Explained

By F. J. Tebbutt

The Export Guarantees Act, 1949, amplifies certain powers given to the Board of Trade, giving guarantees in relation to the export trade, introduces new provisions and at the same time repeals former measures but embodies most of the provisions in the new Act. The Acts repealed are the Export Guarantees Acts, 1939 to 1948, and the Overseas Trade Guarantees Act, 1949. The present Act really relates to schemes of insurance, guarantees being given by the Government against possible loss in export trading, but other information is also available from the Export Credits Guarantee Department of the Board of Trade, as regards foreign firms, type of trade likely to be done and business possibilities generally. By this 1949 Act the liability of the Board of Trade as regards guarantees can extend to (*a*) £500 millions instead of £300 millions allowed by the 1948 Act; at the same time the amount of the liability in respect of (*b*) special matters (matters somewhat as under the Overseas Trade Guarantees Act, 1939) is raised from £60 millions to £100 millions, this being in addition to the sum under (*a*). The powers of the Export Guarantees Department (under the Board of Trade) are somewhat different for (*a*) than for (*b*). For (*a*) guarantees are ordinary commercial guarantees, which are given after consultation with an Advisory Council; for (*b*) the Department can give guarantees without consulting the Council, and in respect of transactions which would not normally be considered as reasonable commercial propositions, but which may be considered as desirable to be given in the national interest. Under (*b*) also, guarantees can be given for rendering economic assistance to countries outside the United Kingdom, and another good example of these special risks which can be undertaken is where there may be "fixed price" contracts for capital goods which require a very lengthy period of manufacture (say, five years or more) and where increases in prices of materials and cost of labour may occur between date of order and delivery of the goods and so forth. Considered also in this category are trade in capital equipment (*e.g.*, machinery and plant, etc.) and contracts which involve large sums being laid by for long periods, etc. In some cases a risk may be divided betwen the (*a*) and (*b*) guarantees. As regards trading arrangements with governments of other countries (*e.g.*, credits to allow purchases of United Kingdom and Empire goods), supplies to Russia, Poland, Austria, and Yugo-Slavia have been covered at different times. Under former Acts there were certain limitations in procedure laid down. Now, roughly, guarantees can be given for any transaction which may be in the national interest, and which will encourage trade with, and result in earnings from, places outside the United Kingdom, and guarantees cover all exports whether visible or invisible and guarantees can apply in relation to commercial assistance to foreign countries.

Apart from goods, a guarantee can apply to the execution of works or services outside the United Kingdom, including the provision of labour and materials. Thus the cost of the installation of machinery or plant or the erection of buildings, etc., can be covered, as can, also, the fees of experts and consulting engineers, and the cost of training employees abroad. Under the guarantee provisions additionally can come the use on a rental basis of a United Kingdom contractor's own equipment in connection with the execution of engineering works abroad.

Sales by merchants and sales from stocks abroad can be covered and guarantees given in connection with the financing of overseas sales agencies. United Kingdom merchants can use the guarantees scheme to cover raw materials and primary products produced abroad and shipped from a foreign country to another such country without coming here, and this applies also in respect of *entrepôt* trading.

Policies

The policy ordinarily used is the E.C.G. Dept. (Contracts) Policy; this covers practically every description of loss which may occur in export trading, perhaps the most important being cover against loss through the insolvency of the buyer (or protracted default in payment). This insurance secures 85 per cent. of the contract price in respect of this risk (*i.e.*, insolvency, bad debts, long credit, etc.), and 90 per cent. for the other cover in the contract, with possibilities of other money coming afterwards, if the estate yields anything.

Premiums vary according to the country of export and the risks involved, and so may be as low as 5s. and as high as 40s. per £100 of turnover, but if the turnover is of reasonable proportions, the premiums usually work out on average at £1 per £100 of turnover or even less (in many cases an average of 15s. applies). For capital goods, machinery, plant, equipment, etc., special policies usually apply, these being according to the individual circumstances of the particular case, but, even so, these are ordinarily based on the standard Contracts policy. In conclusion it might be interesting to note, that for 28 years this guarantees scheme has been operating, and during that time, and up to now, no charge has fallen on the Exchequer.

Index to Volume 86

The index to Volume 86 (January to June) of the FOUNDRY TRADE JOURNAL is now ready. Copies are available, *gratis*, upon application to the Publisher, FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

THE DEATH OCCURRED last Saturday, at the age of 56, of Mr. Donald Wilfred Maddock, while he was on holiday near Bristol. Mr. Maddock was chairman and managing director of John Maddock & Company, Limited, ironfounders, of Oakengates, Salop, and a director of British Fittings Company (Hendon), Limited. He was on the committee of the National Association of Malleable Ironfounders.

British Blast Furnaces in the June Quarter, 1949

These tables are published through the courtesy of the British Iron and Steel Federation.

Derby, Leicester, Notts, Northants and Essex.

Name of firm.	In blast, July 2, 1949, making :—				Weekly average in blast.		Total built.	Furnaces relining.
	Hematite.	Forge and foundry.	Basic.	Total.	June, 1949 quarter.	March, 1949 quarter.		
Clay Cross	—	1	—	1	1	1	2	—
Ford Motor	—	1	—	1	1	1	1	—
Holwell Iron	—	3	—	3	3	3	5	1
Kettering Coal & Iron	—	2	—	2	2	1·8	2	—
New Cransley Iron & Steel	—	1	—	1	1	1	2	1
Renishaw Iron	—	2	—	2	2	2	2	—
Sheepbridge	—	1	—	1	1	1	1	—
Stanton Ironworks : Stanton-by-Dale	—	5	—	5	3·6	4·8	5	—
Staveley Iron & Chemical	—	4	—	4	3·8	4	4	—
Stewarts and Lloyds : Corby	—	—	4	4	4	4	4	—
Wellingboro' Iron	—	1	1	2	2	2	3	1
Total	—	21	5	26	24·4	25·6	31	3

Lancashire (excl. N.-W. Coast), Denbigh, Flint and Cheshire.

Brymbo Steel	—	—	1	1	0·9	1	1	—
Darwen & Mostyn	—	—	—	1*	1	1	1	—
Lancashire Steel Corp'n.	—	—	2	3†	3	3	4	1
Total	—	—	3	5	4·9	5	6	1

* Producing ferro-manganese and spiegeleisen. † Includes one producing ferro-manganese and spiegeleisen

North-West Coast.

Barrow Ironworks	2	—	—	2	2	2	3	—
Charcoal Iron	—	—	—	—	0·6	1	1	1
Millom & Askam	2	—	—	2	2	2	3	1
United Steel : Workington	2	—	—	2	2	2	3	1
Total	6	—	—	6	6·6	7	10	3

Lincolnshire.

Appleby-Frodingham	—	—	9	9	9	8·5	9	—
Lysaght, J. : Scunthorpe	—	—	4	4	4	3·7	4	—
Thomas, E., & Baldwins : Redbourn	—	—	2	2	2	2	2	—
Total	—	—	15	15	15	14.2	15	—

North-East Coast.

Cargo Fleet Iron	—	—	2	2	2	2	2	—
Consett Iron	1	—	1	2	2	2	2	—
Dorman, Long : Acklam	—	—	3	3	3	3	4	1
Redcar	—	—	2	2	2	2	2	—
Cleveland	—	—	2	2	2	2·8	5	—
Bessemer	—	—	2	2	2	2	3	1
South Bank	—	—	—	2*	2	2	4	—
Grangetown	—	—	—	—	—	—	2	—
Gjers, Mills & Co.	2	—	—	2	2	2	5	—
Pease & Partners	2	—	—	2	2	2·2	3	1
Skinningrove Iron	—	—	2	2	2	2	2	—
South Durham Steel & Iron	—	—	2	2	2	2	3	—
Total	5	—	16	23	23	24	37	3

* Producing ferro-manganese.

Scotland.

Bairds & Scottish Steel : Gartsherrie	1	1	1	3	3	3	5	1
Carron	—	1	—	1	1	1	4	1
Coltness	—	—	3	3	2·8	2·2	3	—
Dixon's	—	2	—	2	2	2	6	1
Total	1	4	4	9	8·8	8·2	18	3

Moulding Sand Production

In a Paper which was presented to the Refractories Association of Great Britain, Mr. R. O. Warburg, M.A., quoted the annual production of moulding and pig-bed sand for the years 1938 to 1947. The table reads:—

Year.	*Production.*
1938 ...	770,910
1939 ...	840,607
1940 ...	680,768
1941 ...	528,974
1942 ...	718,124
1943 ...	705,113
1944 ...	691,240
1945 ...	583,046
1946 ...	720,604
1947 ...	694,537

As the output of castings has been increasing since the war, there would appear to have been a commendable economy in the use of moulding sands.

National College

The new prospectus of the National Foundry College for 1948-49 has recently been published. Mr. W. Prentice, B.Sc., has been appointed as assistant lecturer. Part I of the diploma course will begin towards the end of next month and will close in March, 1950. Part II will also commence towards the end of next month and will continue until July, 1950. The hostel, Tor Lodge, a country house some three miles from Wolverhampton, is now available to accommodate a proportion of the students. Details of the curriculum, tuition fees, scholarships, etc., may be obtained from Mr. J. Bamford, National Foundry College, at the Wolverhampton and Staffordshire Technical College.

House Organs

Steel News, Vol. 1, *No.* 1. Issued by the British Iron and Steel Federation, Steel House, Tothill Street, London, S.W.1. This monthly publication presents articles on topics of general interest to the ordinary public, but which are not too likely to reach them through their normal reading. The first issue has achieved its object remarkably well and it will not be easy to maintain the standard set. As it is unpriced, it can be presumed that distribution will be mainly by a mailing list. Being of a type suitable for use in waiting rooms, and the like, it is suggested that readers apply to Steel House to receive this and future copies.

Albion Works Bulletin, Vol. 3, *No.* 6. Published by John Harper & Company, Limited, Albion Works, Willenhall. So the moulding box situation is now satisfactory! The remark is made because for several months the reviewer has followed with interest the steps taken as a result of discussion in the Joint Production Committee. The distribution of metal has also been studied with satisfactory results. Of major interest is that this works, one of the tidiest in the country, has recently salvaged and sold ten tons of steel scrap. These activities typify the good work that can result from mutual discussion.

"DIE SLICK," the trade name of an American die dressing and lubricant, is not at present on the British market, but arrangements are well ahead for its sale soon.

British Blast Furnaces in the June Quarter, 1949—*cont.*

Staffordshire, Shropshire, Worcestershire and Warwickshire.

Name of firm.	In blast, July 2, 1949, making:— Hematite.	Forge and foundry.	Basic.	Total.	Weekly average in blast. June, 1949, quarter.	March, 1949, quarter.	Total built.	Furnaces relining.
Goldendale Iron	—	1	—	1	1	1	2	1
Lilleshall	—	1	—	1	1	1	2	1
Round Oak Steelworks	—	1*	—	1	1	1	3	—
Shelton Steel & Iron	—	—	3	3	3	3	3	—
Stewarts and Lloyds: Bilston	—	—	3	3	3	3	3	—
Total	—	3	6	9	9	9	13	2

* Cold-blast pig-iron.

South Wales and Monmouthshire.

Briton Ferry Works	1	—	—	1	1	1	1	—
Guest, Keen, Baldwins: Cardiff	1	—	2	3	3	3	4	1
Thomas, R., & Baldwins: Ebbw Vale	—	—	2	2	2	2	3	1
Steel Co. of Wales: Margam	—	—	2	2	2	2	2	—
Total	2	—	6	8	8	8	10	2

Sheffield.

Park Gate Iron & Steel	—	—	1	1	1	1	2	—
GRAND TOTAL	14	28	56	102*	100·7	102	142	17

*Includes four making ferro-alloys.

Number of Furnaces in Blast on July 2, 1949

District.	Weekly average in blast, June quarter.	Total in blast, July 2, 1949.	In blast July 2, 1949, making:— Hematite.	Forge and foundry.	Basic.	Ferro-alloys.
Derby, Leics., Notts., Northants and Essex	24.4	26	—	21	5	—
Lancs. (excl. N.-W. Coast), Denbigh, Flint and Ches.	4·9	5	—	—	3	2
Lincolnshire	15	15	—	—	15	—
North-East Coast	23	23	5	—	16	2
Scotland	8·8	9	1	4	4	—
Staffs., Shrops., Worcs. and Warwick	9	9	—	3	6	—
S. Wales and Monmouth	8	8	2	—	6	—
Sheffield	1	1	—	—	1	—
North-West Coast	6·6	6	6	—	—	—
Total	100·7	102	14	28	56	4

Weekly Average Number of Furnaces in Blast during the Previous Six Quarters

District.	1949. March	1948. Dec.	Sept.	June.	March.	1947. Dec.
Derby, Leics., Notts., Northants and Essex	25.6	25	25.6	25.7	25.4	24.3
Lancs. (excl. N.-W. Coast), Denbigh, Flint and Ches.	5	5	5	5	5	4.7
Lincolnshire	14.2	14	13.5	13.8	13.7	13
North-East Coast	24	25 5	25.2	25.2	25.7	25
Scotland	8.2	9	9	9	9.1	8.5
Staffs., Shrops., Worcs. and Warwick	9	8.8	8	8	8	7.1
S. Wales and Monmouth	8	7.6	7.8	7.7	7	6.9
Sheffield	1	1	1	1	1	1
North-West Coast	7	7.2	6.8	6.4	7	7
Total	102	103.1	101.4	101.8	101.9	97.5

The following companies have furnaces in course of construction:—Darwen & Mostyn, 1; Lancashire Steel Corporation, 1;; Steel Co. of Wales. 1: Sheepbridge Company, 1; Consett Iron, 1; Skinnin grove Iron, 1 R. Thomas & Baldwins (Redbourn), 1; Barrow Ironworks, 1; Cargo Fleet Iron, 1.

News in Brief

THE *Association Technique de Fonderie* has changed its address from 66, Rue Boissiere to 2, Rue de Bassano, Paris, 16.

THE BRITISH WELDING RESEARCH ASSOCIATION announce that as from August 13 their telephone number will be changed to Langham 7485/9.

THE BRITISH INSTITUTE OF MANAGEMENT has issued a 12-page propaganda booklet entitled "Service for Management," which details the services accorded by the Institute to its members. These are in line with most of the learned societies.

MR. HARRY LANE, chairman of Heenan, Beddow & Sturmey, Limited, in his statement with the annual report, says that the foundry business of the subsidiary company is working well and making good profits. The range of castings has been extended, thereby enabling the number of customers to be increased.

THE DIRECTORS of the Staveley Coal & Iron Company, Limited, announce that the preparation and completion of consolidated accounts will necessitate the next annual meeting being held on October 26, instead of in September as formerly. Payment of such final dividend as may be deferred for the year to June 30 will be made on October 31.

THE MINISTRY OF LABOUR'S Safety, Health and Welfare Museum, Horseferry Road, London, S.W.1, is showing a special rubber glove fitted with an exhaust with its aperture located beneath the bend of the little finger. It then follows the line of the back of the gauntlet and continues as a flexible pipe. It has been designed for use by stonemasons so as to carry away dust at the point of creation and thereby eliminate the risk of silicosis.

AT THE International Mechanical Engineering Congress, which is to be held in Paris from September 12 to 17, the British exchange Paper will be "The Advancement of Production Efficiency," by Mr. A. W. Berry (director of the British Engineers' Association). Works visits include the mechanised light alloy foundry of Japy Frères, at Arcueil, and the iron and steel foundries of the Régie Nationale de Usines Renault, at Boulogne-Billancourt.

THE DIRECTORS OF Sentinel (Shrewsbury), Limited, producers of Diesel road vehicles, machine tools, etc., state that there are indications that the company will have to meet an increasingly competitive market for its products. Profits in the current year "may be below those of the year just completed." It is added that substantial modifications in the design of existing models are now necessary and current production consequently may be on a reduced scale.

A FURTHER CAPITAL EXPENDITURE of over £8.000.000 will be involved in the second stage of Dorman, Long & Company's major development plan, which is to be put in hand immediately. The building of the projected open-hearth steel plant at Lackenby with a capacity of 10,000 tons of ingots per week, the extension of the new ore-grading plant at the Cleveland Works, and the installation of new blast-furnace ancillary equipment are included in this second stage, and it is anticipated that all this work can be completed by September, 1952.

THE DIRECTORS of the Hill Top Foundry Company, Limited, Wednesbury, Staffs, have announced a 300 per cent. capital bonus by a writing up of fixed assets. In their annual report the directors draw attention to the incorporation of fixed assets in the balance-sheet on the basis of the qualified valuation made at March 31, 1947. The valuation exceeded previous written down values by £101,170, or £97,238 net, after allowing for additional depreciation. The three-for-one capital bonus for ordinary shareholders registered on July 28 absorbs £45,000 of capital reserve.

MUREX, LIMITED, metallurgists, of Rainham, Essex, announces that the Treasury has given consent to the directors' proposal to capitalise £1,000,000 of the company's reserves and to issue to the ordinary stockholders one fully-paid ordinary £1 share for each £1 unit held by them. The proposal will be proceeded with and appropriate resolutions will be submitted at the annual meeting to be held on September 12. The directors state that the overall demand for the company's products has continued at a satisfactory level and that supplies of steel for the manufacture of welding electrodes have much improved.

A SCIENTIFIC SURVEY of North-Eastern England, giving an authoritative and concise picture of the region's natural history, its industries past and present and its part in the nation's economy, has been issued by the Newcastle-upon-Tyne executive committee of the British Association, which holds its meeting there from August 31 to September 7. Contributors to the section of the survey on local industries include Mr. H. B. Robin Rowell, chairman of R. & W. Hawthorn, Leslie & Company, Limited, Hebburn, and Mr. P. L. Jones, general manager, engineering department of Swan, Hunter & Wigham Richardson, Limited, Wallsend.

THE DIRECTORS of W. G. Allen & Sons (Tipton), Limited, Princes End Works, Tipton, have started a profit-sharing scheme from which £3,112 has already been distributed to employees. Although introduced very recently, the scheme was backdated to April 1, 1948, and the firm's 400-odd employees have received sums varying from £10 to £15. Mr. John H. Plant, joint-managing director, states that payments made under this scheme are gifts from the company to its employees, and will be calculated in such a way as to put all employees in the position of being partners in the business, directly participating in the profits made.

Increases of Capital

Details of increased capital have been announced by the following companies:—

HENRY BROOK & COMPANY, LIMITED, ironfounders and general engineers, etc., of Huddersfield, increased by £10,000, in £5 shares, beyond the registered capital of £10,000

HOLT (MARINE FACTORS), LIMITED, founders, boat builders, etc., of London, E.C.2, increased by £3,000, in £1 7½ per cent. cumulative preference shares, beyond the registered capital of £2,000.

Association Technique de Fonderie

23rd Annual Conference

The 23rd Annual Conference of the *Association Technique de Fonderie* is to be held on October 10 and 11 at 9, Avenue d'Péna, Paris, 16. The following programme has been arranged:—

Monday, October 10

9.15 a.m.—Presidential Address by Dr. Ballay, with Mr. Pierre Bellier, Director of Mechanical and Electrical Industries, Ministry of Industry and Commerce, in the chair. The address will be followed by technical Papers: "Improving Working Conditions in the Foundry," by Mr. A. Cappon (Netherlands Exchange Paper); "Combating Poor Working Conditions in the Foundry Industry," by Mr. P. Rigaut; "Can Foundries, especially Small Ones, be Made to Conform to Rational Methods of Operation?" by Mr. R. Goreaud, and "Some Tendencies in the Methods of Production of Grey-iron Castings in Great Britain," by Mr. R. C. Shepherd (British Exchange Paper).

At 2.15 p.m.—The technical session recommences with "The Influence of Speed on Tensile Test Results on Grey-iron Specimens—A Statistical Study," by Mr. J. Gelain; "A Contribution to the Study of High-phosphorus Irons," by Mr. J. Galey; "The Solidification and Structure of Cast Irons," by Mr. A. Descy (Belgian Exchange Paper); "The Welding of Cast Iron in Relation to its Complex Structure," by Mr. H. Gerbeaux; "The Estimation of Chromium in Ferrous Metals," by Mr. L. Roget, and "The Electro-chemical Etching Method Applied to Cast-iron Micro-sections and the Measurement of the Amount of Attack Obtained in Each Particular Case," by Prof. E. Gèrardet.

Tuesday, October 11

8.45 a.m.—The morning will be devoted to "The Grain of Cast Irons," by Mr. L. Grand; "Influence of a Previous Oxidation on the Resistance to Corrosion of Irons by Molten Light Alloys," by Prof. P. Bastien and Mr. P. Azou; "Tendencies in Aluminium Alloys for Moulding," by Mr. W. Bonsack (American Exchange Paper); "Copper-base Alloys for Castings," by Mr. J. S. Vancck; "Notes on Dies for the Gravity Casting on Aluminium Alloys," by Mr. P. Fouron and Mr. R. Bourret; (afternoon session at 2.15 p.m.) "A Contribution to the Training of Foundry Students in General Engineering," by Mr. Ed. Lecoeuvre; "The Education of Foundry Apprentices," by Dr. A. Plesinger (Czecko-slovakian Exchange Paper), and "Craft Training in France," by Mr. D. Waeles, together with a documentary film. The summing-up of the technical sessions of the Conference will be undertaken by Dr. Ballay, the President of the Association. At 8 p.m. will be held the Annual Dinner at the Restaurant Ledoyen, Avenue de Champs Elysées (day dress).

Wednesday, October 13

Morning.—Visit to the Renault Works and the Suresnes Apprentice Centre.

Afternoon.—Visit to the works of the *Société Industrielle de Fonderie d'Aluminium* and the *Fonderie de Précision de Manterre.*

Readers wishing to participate in this Conference should write for particulars to the Secretary of the Association Technique de Fonderie at 2, Rue de Bassano, Paris, 16.

Malleable Iron Annealing—Discussion

(*Continued from page* 188.)

special attention to the section studied, as this had a pronounced effect upon the original grain size and, as a result, on the normal nodule count. The Author was to be congratulated on this work and stimulated to further endeavours.

Nodule-count Data

MR. PALMER, commenting upon the written discussion made by Mr. A. E. Peace, said that the nodule-count data were included in the Paper to further demonstrate the differences in temper-carbon distribution, and to substantiate the metallographic illustrations. He agreed that if the nodule-count results were converted from linear counts into numbers per unit volume by the approximate method employed by Schwartz, then a more accurate relationship would be provided.

On the question of nomenclature concerning the term secondary graphitisation, he was inclined to agree that the use of second-stage graphitisation would be more suitable. This was already in common use in black-heart annealing, and could be equally well applied to whiteheart. In the annealing of conventional cupola-melted whiteheart iron, of course, very little second-stage graphitisation occurred.

The importance of avoiding the retention of hyper-eutectoid cementite network in annealed whiteheart iron could not be over-emphasised, if good shock resistance was to be maintained. It had been the Author's experience that, when this constituent was contained in a material in any quantity, then the elongation value obtained from the tensile testing of such a material was invariably poor. Whiteheart iron of high excess-sulphur content normally exhibited a low elongation because of its hyper-eutectoid cementite content. It was quite difficult to detect this constituent by a visual examination of the fracture of whiteheart iron.

Mr. Peace quite rightly pointed out that section size was of importance in a consideration of annealability and the number of temper-carbon nodules likely to be formed during the annealing of a material. In general, the larger the section size, the coarser was the general structure of the white iron and the smaller the number of nodules subsequently formed by annealing.

REFERENCES

[5] "The Metallurgy of Malleabilisation." White and Schneiderwind. Trans. A.F.A. (1932), Vol. 40, p. 88.
[6] "Effect of Super Heat on Annealing of Malleable Iron." White and Schneiderwind. Trans. A.F.A. (1933), Vol 41, p. 98.
[7] "A Simple Approximate Method for Determining Nodule Number." Schwartz. "Metals and Alloys," Vol. 7, p. 276 (1936).

Raw Material Markets

Iron and Steel

Orders at present on hand ensure steady employment and reasonable outputs and, taking the foundry trade as a whole, all available supplies of pig-iron and hematite are readily absorbed. In fact, the maximum output of the high-phosphorus grade of pig-iron barely meets the light foundries' needs. Some of these users complain that their deliveries are well below their licensed tonnages, and the quantities allocated by the furnaces have not been forthcoming due to production difficulties. With the reduction in output in the Derbyshire area, the supplies available from other producing units are fully taken up.

The low- and medium-phosphorus grades of pig-iron for the engineering, jobbing, and specialty foundries are not too plentiful and larger tonnages would be welcomed. Supplies of hematite are showing some improvement and the refined grades of pig-iron can be secured without difficulty. Scrap supplies for cupola use are also more plentiful, but available quantities are taken up promptly. Coke deliveries are satisfactory and there are few complaints regarding quality and size. Supplies of other requisites, including ganister, limestone and firebricks, are sufficient for requirements.

Outputs from the re-rollers are being maintained at an improved level. The light re-rollers are busily engaged on the light sections, bars and narrow strip, and their deliveries are more in line with consumers' requirements than for some time past, although extended delivery is still quoted for some of the thinner gauges. Sheets, both black and galvanised, are still in strong demand, particularly the thinner gauges, and although additional supplies of sheet bars are enabling the mills to step up production, supplies are insufficient to meet all requirements. At the heavy mills outputs of the heavier sizes of sections, bars and wide strip are satisfactory.

Non-ferrous Metals

Encouraged by firm sessions on Wall Street, the commodity markets in America last week showed a very steady front, lead being in demand at rising prices. The continued support afforded to lead by consumers, principally the battery makers, has been a feature of the American situation for a week or two now, and there was a fairly general feeling that the recovery would take the quotation up to 15 cents per lb. by the end of the week. By Wednesday 14¾ cents had been reached, and the Ministry of Supply advanced its selling limit by £1 7s. 6d. to £85 2s. 6d. per ton. On Monday of this week a leading U.S. custom smelter raised its lead price by ¼ cent to 15¼ cents per lb., and on the following day the U.K. price moved up by £2 2s. 6d. to £87 5s. per ton. Buying in the United Kingdom, however, is slight, for the quota scheme is still in force, and consumers secured most of their cover for the third quarter early in July, when the price was much lower.

Copper is unchanged in New York at 17⅞ cents, and zinc steady at 10 cents per lb., with a modest amount of buying of both metals. For the present sentiment inclines more towards a rise in metal prices than a fall, but there are, nevertheless, many factors making for uncertainty. Stocks are increasing in Britain and traders are wondering whether the authorities are going to continue to buy at the present rate. Consumers, mainly because of the existence of a high contango for forward dates, are confining themselves to purchases for nearby delivery and are hardly likely to be persuaded to do otherwise. Next year will certainly see a reduction in U.K. imports of dollar metal and unless demand improves considerably in the United States, copper, at any rate, is likely to show a surplus on the world markets.

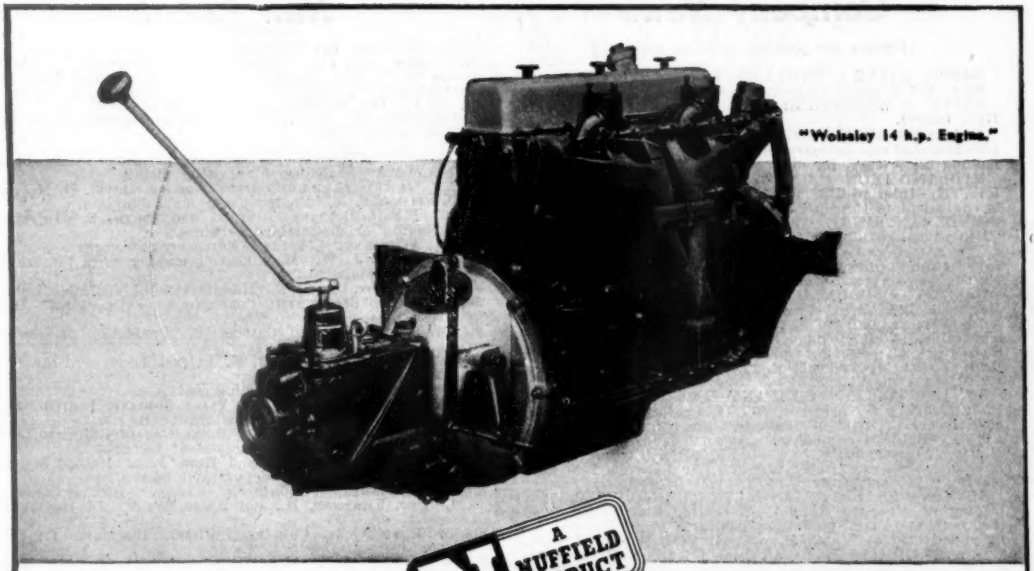
In the meantime, as already mentioned, stocks are on the upgrade; in the case of copper, reserves rose from 117,491 tons at May 31 to 127,025 tons at the end of June. Figures furnished by the British Bureau of Non-ferrous Metal Statistics give the June consumption of copper at 41,210 tons, compared with 42,249 tons in May. Usage of virgin copper in June advanced by about 4,000 tons to 27,404 tons, but there was a decline of 5,186 tons in secondary copper. Zinc stocks also advanced, from 60,741 tons at May 31 to 75,389 tons at June 30. Lead stocks at June 30 amounted to 59,648 tons, against 47,316 tons a month earlier. At the end of March reserves stood at no more than 26,386 tons.

European Supplies of Non-ferrous Metals

Complex problems face the Non-ferrous Metals Committee of the Organisation for Economic Co-operation, which declares in a recent report that all participating countries will, to a great extent, have to forgo purely national policies and survey the position of Western Europe as a whole. The Committee recommends that special meetings of experts should be called as early as possible to study the two problems of feeding the Western European smelters and refineries with the necessary supplies of ores, and employing in the best possible way the potentially enormous capacity of the participating countries to transform metal into semi-manufactured products in order to supply the needs of consumer industries, not only in Western Europe, but in all parts of the world.

All steps which will augment supplies on the world markets should be taken. "Without exception, supplies are short and these metals are of supreme importance in the U.S. Government's strategic stockpiling proposals."

It seems very likely that the present shortage of copper, lead, and zinc will persist for some time to come. Substitution of aluminium for copper offers one of the few ways open to all countries for easing the copper situation. The major problem is to increase mine production in order to overcome the world shortage of all these metals and, if possible, to reduce the present too high world prices. There is ample capacity for treating the minerals once they have been produced. In fact, the problem is to limit the extension of existing facilities.



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Company News

(Figures for previous year in brackets.)

GJERS, MILLS & COMPANY—Dividend of 8% (same).

SHANKS & COMPANY—Interim dividend of 5% (same).

SMITH & WELLSTOOD—Final dividend of 12½%, making 17½% (same).

BLAKEY'S BOOT PROTECTORS—Final dividend of 12½%, plus bonus of one ordinary share for every three held (12½%), making 22½% (22½% for nine months).

MIDLAND IRON & HARDWARE COMPANY (CRADLEY HEATH)—Interim dividend of 25% on increased capital, which is equivalent to the interim payment of 100% last year.

WELLMAN SMITH OWEN ENGINEERING CORPORATION—Final dividend of 7½%, making 12½%, less tax (same), and a special cash bonus at the rate of 5% (nil), tax free, from surplus provision in respect of taxation in previous periods now in excess of requirements.

HILL TOP FOUNDRY COMPANY—Trading profit to March 31, £55,548; subsidiary's net profit, £1,060; retained by subsidiary, £1,060; to depreciation, £7,104; directors' remuneration, £6,550; employees' bonus, £3,975; tax, £22,247; leaving £15,672; brought in, £8,080; to preference dividend, £413; ordinary dividend of 100%, £8,250; general reserve, £2,500; forward, £12,589.

BEESTON BOILER COMPANY—Trading profit to March 31, £181,572 (£130,312); fees, £10 (£12); to depreciation and obsolescence written off buildings, machinery, plant, etc., £10,541 (£13,550); employees' pension fund, £500 (same); directors' remuneration, £8,850 (£8,700); leaving £161,691 (£107,574); to tax, £88,099 (£59,929); final dividend of 27½%, making 37½% (same); forward, £74,102 (£47,634).

DAVY & UNITED ENGINEERING COMPANY—Profit on trading of group to March 31, including sundry income for the year and part profits on contracts completed but not fully delivered at March 31, £221,441 (£251,449); to depreciation, £39,434 (£40,398); provision for doubtful debts, £15,000 (£12,000); auditors' remuneration, £1,058 (£1,058); additional provision for contingent claims arising out of completed contracts, £7,591 (£9,113); additional provision for deferred repairs, £7,487 (£37,923); estimated income tax, £40,163 (£42,110); estimated profits tax, £22,000 (£19,850); adjustment of excess profits tax and income tax of previous years, nil (£8,790); net profit, £88,708 (£97,787); dividend of 7½% (same); replacement reserve, £30,000 (same); general reserve, nil (£50,000); forward, £96,978 (£77,096).

New Companies

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

W. MEAKING & COMPANY, 71, Howe Street, Birmingham, 4—Metal merchants and refiners. £30,000. W. L. and E. K. Meaking.

LYNDON BRASSFOUNDERS, Lyndon Works, 88, Edward Road, Balsall Heath, Birmingham, 12—£3,000. A. Cleaver and W. Packham.

H. J. EXLEY, The Old Brass Foundry, Load Street, Bewdley, Worcs—Brassfounders, machinists, etc. £4,000. K. A., R. J. and E. S. Exley.

WILLIAMS & MICHELL, Longmead Avenue, Bristol, 7—Iron and steel merchants. £15,000. M. S. Michell, A. L. Phillips and C. H. Maggs.

JAMES MILLS (MONTROSE), 17, Lowerhall Street, Montrose—£5,000. Iron, steel and general metal merchants. J., J. and J. Mills and F. Webster.

ALEXANDER BROWN & COMPANY (GLASGOW), 113, West Regent Street, Glasgow—£5,000. Metal merchants and agents. C. and E. Hedderwick.

D. H. BLAKE & COMPANY, 26, Addison Place, Notting Hill, London, W.11—Engineers' patternmakers, etc. £5,000. D. H. Blake. R. G. Somers and T. A. Moreton.

New Patents

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed, and all subsequent proceedings will be taken.

612,846 Soc. d'Applications Mechaniques pour l'Automobile, S.A.M.P.A. Machines for casting metals.

613,514 General Electric Company, Limited, Dovey, D. M., and Williams, S. V. Production of malleable iron.

613,597 E.M.B. Company, Limited, and Smith, S. Injection moulding or die-casting machines.

613,874 Blaw-Knox Company. Furnace-port coolers.

614,693 Athey, J. W. Machines for making cores for use in casting metals.

615,307 Robiette, A. G. E. Manufacture of malleable iron.

615,621 United States Steel Corporation of Delaware. Hot-blast stoves.

615,704 Koller, K., and Galocsy, Z. Production of iron in blast furnaces.

615,720 Cape, A. T., Brassert, H. A., and Thomas, L. H. Production of iron.

615,958 Fassotte, P. C. Founding metals.

616,166 Dowson & Mason Gas Plant Company, Limited, and Leonard, L. G. A. Heat-treatment furnaces.

616,167 Dowson & Mason Gas Plant Company, Limited, and Leonard, L. G. A. Heat-treatment furnaces.

616,554 Tama, M., Tama, M., and Hoff, J. L. Method of and apparatus for melting copper and lead alloys.

616,656 Birmingham Aluminium Casting (1903) Company, Limited, Fairbairn, H., and Baker, W. A. Die-casting of metals.

616,784 Mond Nickel Company, Limited. Inoculants for cast iron.

616,796 Holden, A. de F. Molten salt baths for the heat-treatment of ferrous articles.

616,839 Sintered Products, Limited, and Lennox, J. W. Manufacture of porous metal.

517,002 Chromium Mining & Smelting Corporation, Limited. Production of high-strength cast iron.

Obituary

Mr. Donald W. Maddock, chairman and managing director of John Maddock & Company, Limited, malleable ironfounders, of Oakengates, Shrops, died recently whilst on holiday. He had been a member of the Institute of British Foundrymen for 24 years.

Mr. William Bell, of Maryport, Cumberland, has recently died. He joined the Institute of British Foundrymen in 1910 and presided over the Scottish Branch during the 1919-1920 session. Mr. John Bell, honorary secretary of the Scottish Branch, writes: "The deceased was one of the pioneers of foundry technology and was an ornament both to his profession and to the Institute. The industry has lost much by his passing."

Mr. Alfred R. Tattersall, chairman of Groom & Tattersall, Limited, ironfounders and engineers, Towcester, has died. In 1894 he joined Mr. M. W. Groom to produce a new flour milling machine that he had invented. This proved a great success, and Mr. Tattersall travelled in many countries selling the machine. In 1917 the business was converted into a limited company and, in 1937 Mr. Tattersall became chairman of directors.

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Current Prices of Iron, Steel and Non-ferrous Metals

(Delivered, unless otherwise stated)

August 10, 1949

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £10 4s.; Birmingham, £10 0s. 6d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £11 15s. 6d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si)—North Zone, £12 2s. 6d.; South Zone, £12 5s.

Scotch Iron.—No. 3 foundry, £11 18s. 3d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £12 14s. 6d.; South Zone, £12 17s.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £13 4s. 6d.; South Zone, £13 7s.

Cold Blast.—South Staffs, £15 16s. 6d.

Hematite.—Si up to 2¼ per cent., S & P over 0.03 to 0.05 per cent.; N.-E. Coast and N.-W. Coast of England, £11 16s. 6d.; Scotland, £12 3s.; Sheffield, £12 9s.; Birmingham, £12 15s.; Wales (Welsh iron), £11 16s. 6d.

Spiegeleisen:—20 per cent. Mn, £17 8s.

Basic Pig-iron.—£9 17s. 6d., all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, basis 2-ton lots, d/d Sheffield works.)

Ferro-silicon (6-ton lots).—20/30 per cent., £25 15s.; 40/55 per cent., £32 10s.; 70/85 per cent., £49.

Ferro-vanadium.—35/50 per cent., 15s. per lb. of V.

Ferro-molybdenum.—70/75 per cent., carbon-free, 6s. 5d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, 1s. 3½d. lb.

Ferro-tungsten.—80/85 per cent., 7s. 9d. lb.

Tungsten Metal Powder.—98/99 per cent., 8s. 9d. lb.

Ferro-chrome.—4/8 per cent. C, £60; max. 2 per cent. C, 1s. 5d. lb.; max. 1 per cent. C, 1s. 5½d. lb.; max. 0.15 per cent. C, 1s. 6½d. lb.

Cobalt.—98/99 per cent., 12s. lb.

Metallic Chromium.—96/98 per cent., 5s. 1d. lb.

Ferro-manganese (blast-furnace).—78 per cent., £25 3s.

Metallic Manganese.—94/96 per cent., carbon-free, 1s. 9d. lb.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms and Slabs – BASIC: Soft, u.t., £16 16s. 6d.; tested, up to 0.25 per cent. C (100-ton lots), £17 1s. 6d.; hard (0.42 to 0.60 per cent. C), £18 16s. 6d.; silico-manganese, £23 19s.; free-cutting, £20 1s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £22 4s.; case-hardening, £23 1s. 6d.; silico-manganese, £26 6s. 6d.

Billets, Blooms and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £19 16s. 6d.; basic, hard, over 0.41 up to 0.60 per cent. C, £21 1s. 6d.; acid, up to 0.25 per cent. C, £23 1s. 6d.

Sheet and Tinplate Bars.—£16 16s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Plates, ship (N.-E. Coast), £20 14s. 6d.; boiler plates (N.-E. Coast), £22 2s.; chequer plates (N.-E. Coast), £22 19s. 6d.; heavy joists, sections and bars (angle basis), N.-E. Coast, £19 13s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £22 6s.; flats, 5 in. wide and under, £22 6s.; rails, heavy, f.o.t., £19 2s. 6d.; hoop and strip, £23 1s.; black sheets, 17/20 g., £28 16s.

Alloy Steel Bars.—1-in. dia. and up: Nickel, £35 14s. 9d.; nickel-chrome, £50 6s. 9d.; nickel-chrome-molybdenum, £55 9s.

Tinplates.—I.C. cokes, 20 × 14, per box, 41s. 6d., f.o.t., makers' works.

NON-FERROUS METALS

Copper.—Electrolytic, £107 10s.; high-grade fire-refined, £107; fire-refined of not less than 99.7 per cent., £106 10s.; ditto, 99.2 per cent., £106; black hot-rolled wire rods, £116.

Tin.—99 to under 99.75 per cent., £569; 99.75 to under 99.9 per cent., £572 10s.; min. 99.9 per cent., £577.

Zinc.—G.O.B. (foreign) (duty paid), £63 10s.; ditto (domestic), £63 10s.; "Prime Western," £63 10s.; electrolytic, £64 5s.; not less than 99.99 per cent., £65 15s.

Lead.—Good soft pig-lead (foreign) (duty paid), £87 5s.; ditto (Empire & domestic), £87 5s.; "English," £88 15s.

Zinc Sheets, etc.—Sheets, 10g. and thicker, ex works, £77 10s.; rolled zinc (boiler plates), ex works, £75 10s.; zinc oxide (Red Seal), d/d buyers' premises, £63 10s.

Other Metals.—Aluminium, ingots, £90; antimony, English, 99 per cent., £160; quicksilver, ex warehouse, £18 10s.; nickel, £224.

Brass.—Solid-drawn tubes, 19⅞d. per lb.; rods, drawn, 10½d.; sheets to 10 w.g., 16d.; wire, 16½d.; rolled metal, 14¾d.

Copper Tubes, etc.—Solid-drawn tubes, 19⅝d. per lb.; wire, 144s. 9d. per cwt. basis; 20 s.w.g., — per cwt.

Gunmetal.—Ingots to L.G.2 (85/5/5/5), £72 to £90; L.G.3 (86/7/5/2), £80 to £118; G1 (88/10/2), £125 to £156 per ton, delivered.

Phosphor-bronze Ingots.—P.Bl, £126 to £170; L.P.Bl, £88 to £118 per ton.

Phosphor Bronze.—Strip, 22¼d. per lb.; sheets to 10 w.g., 24⅝d.; wire, 24⅜d.; rods, 23d.; tubes, 27½d.; chill cast bars: solids, 23d., cored, 24d.; 10 per cent. phos. cop., —; 15 per cent. phos. cop., —; phosphor tin (5 per cent.), —. (C. CLIFFORD & SON, LIMITED.)

Nickel Silver, etc.—Ingots for raising, 1s. 4¾d. per lb. (7%) to 2s. 1d. (30%); rolled metal, 3 in. to 9 in. wide, × .056, 1s. 10¾d. (7%) to 2s. 7d. (30%); to 12 in. wide, × .056, 1s. 11d. to 2s. 7¼d.; to 25 in. wide, × .056, 2s. 1d. to 2s. 9¼d. Spoon and fork metal, unsheared, 1s. 9¼d. to 2s. 5¼d. Wire, 10g., in coil, 2s. 3½d. (10%) to 3s. 0½d. (30%). Special quality turning rod, 10%, 2s. 2¾d.; 15%, 2s. 7d.; 18%, 2s. 11d.

Personal

DR. A. T. THIRD has been appointed a director of Thermotank, Limited, ventilating engineers, Glasgow.

MR. A. ROBERTS has relinquished his position as manager with Ellis Flower & Son, Limited, pattern-makers, of St. Helens, Lancs.

MR. H. J. NOEL has been elected a director of Johnson Matthey & Company, Limited, precious-metal smelters, etc., of Hatton Garden, London, E.C.1.

DR. EDGAR C. BAIN, vice-president of the Chicago Illinois Steel Company, is this year's recipient of the Gold Medal of the American Society for Metals.

MR. J. HOLTERMAN, of the technical staff, and MR. A. H. WHITE, of Lithgows, Port Glasgow, have been appointed directors of Rankin & Blackmore Limited, brass and ironfounders, Greenock.

MR. G. H. WHITE, head of G. H. White & Company, Limited, heat-treatment specialists, of Sheffield, has been appointed to serve on the Gas Consultative Council for the East Midlands Area.

MR. LEWIS CHAPMAN, managing director of William Jessop & Sons, Limited, steel-makers, of Sheffield, has been appointed a member of the Gas Consultative Council for the East Midlands Area.

MR. JOHN MCINNES SLATER, deputy secretary, has been appointed secretary of Drysdale & Company, Limited, pump manufacturers, etc., of Glasgow, in succession to the late Mr. Andrew Climie.

MR. H. WEBSTER, chief engineer at the Scunthorpe works of Thos. Firth & John Brown, Limited, steel-makers, has been appointed to a similar post at the Corby (Northants) works of Stewarts and Lloyds, Limited. He will take up his new duties on September 1.

MR. H. WILLIAMS, of Sterling Metals Limited, who retired at the end of last month, after 29 years as director and secretary of the firm, was presented with an inscribed silver salver, at a luncheon given by his fellow directors. MR. T. BARKER succeeds Mr. Williams as secretary.

MR. J. A LACEY has retired from the position of works manager of the engineering department of the G.E.C. works at Witton, Birmingham, after nearly 46 years' service. He is not, however, completely severing his connection with the company as he will continue to act in an advisory capacity on all Federation matters which have represented an important part of his activities for many years. Mr. Lacey, who is a member of the Institute of British Foundrymen, was presented with two oak bookcases and a combined oak bureau and bookcase by friends and colleagues. He is succeeded by MR. E. YEELES.

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ALL NON-FERROUS
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LIVERPOOL, 2. 13, Rumford St. Central 1558
GLASGOW, C.2. 98, Hope Street, Central 9969

NOTICE

Situations advertised under this heading are available only to applicants excepted from the Control of Engagement Order, 1947, No. 2021.

SITUATIONS WANTED

EXPERIENCED Ironfoundry FOREMAN seeks post; loam, dry and greensand casting for all the engineering trades; expert on cupolas and coreblowing; estimatings and rate fixing; can obtain results without friction.—Box 188, FOUNDRY TRADE JOURNAL.

FOUNDRY FOREMAN (age 47) seeks situation; 33 years' experience nonferrous metals; 1st class moulder; London or area.—Box 198, FOUNDRY TRADE JOURNAL.

FOUNDRY MANAGER (Non-Ferrous) (age 40); technical and practical experience in mechanised and hand production of hydraulic castings to withstand high pressures; accustomed to complete control of foundries producing high quality castings; electric melting and metallurgical control; City and Guilds, M.I.B.F.; free September-October.—Box 200, FOUNDRY TRADE JOURNAL.

INDUSTRIAL RADIOGRAPHER (35) desires change; 7 years' experience X-ray examination castings, welds, etc., light alloys, steels, bronzes; accustomed radiological interpretation; knowledge industrial photography; south preferred.—Box 194, FOUNDRY TRADE JOURNAL.

YOUNG FOUNDRY MANAGER seeks change; fully experienced all branches iron and steel founding; sound metallurgical training; specialist in mechanisation; capable of full control.—Box 196, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

EXCELLENT opportunity energetic practical FOUNDRYMAN, preferably already calling trade, sell new proposition interesting all foundries.—Box 962, FOUNDRY TRADE JOURNAL.

FOREMAN for Coreshop, also FOREMAN on Closing Track, required by Mechanised Midlands Ironfoundry.—Box 168, FOUNDRY TRADE JOURNAL.

GENERAL PATTERNSHOP FOREMAN required for Engineering Company in the Manchester area; used to both specialised production and general mixed classes of work.—Full particulars as to training to Box 122, FOUNDRY TRADE JOURNAL.

METALLURGICAL CHEMIST required for Brassfoundry producing sand and die-castings as well as brass ingots; East London area; good prospects; preference will be given to candidates with a University degree and previous practical experience.—Write in the first instance, stating age, experience, and salary required, to Box 204, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*Contd.*

APPLICATIONS are invited for the appointment of SALES MANAGER in the Light Castings Department of Newton, Chambers & Co., Ltd.

The duties will involve responsibility for sales policy and organisation; control of representatives, and publicity.

Applicants must possess up-to-date knowledge of modern fuel-burning appliances.

Please apply, stating age, experience, education and salary required, to the PERSONNEL OFFICER, Newton, Chambers & Co., Ltd., Thorncliffe, near Sheffield.

ASSISTANT to Chief Works Metallurgist required for works in the Manchester area; applications are invited from men with practical and technical knowledge of the operations and metallurgy of the open-hearth steel melting furnace, heat-treatment of castings, refractories, and general engineering materials.—Full particulars as to training, career and wages, to Box 120, FOUNDRY TRADE JOURNAL.

AN old-established Firm of Non-ferrous Founders in the Croydon area, specialising in jobbing and repetition work, have a number of vacancies for Skilled MOULDERS.—Application, stating age and experience, to Box 966, FOUNDRY TRADE JOURNAL. This advertisement appears by permission of the Ministry of Labour and National Service under the Control of Engagement Order, 1947.

FOUNDRY FOREMAN for Jobbing Foundry, West Riding, Yorks.; 10 tons per week; must be capable of stepping up production.—Write, stating experience, age and salary required.—Box 190, FOUNDRY TRADE JOURNAL.

FOUNDRY FOREMAN required for Tyneside Jobbing Foundry producing Alloyed and High Duty Engineering and Specialised Castings up to 12 tons; must be thoroughly practical, and able to take control; man with initiative, energy and proven ability essential.—Write, stating age, experience, and salary required, Box 112, FOUNDRY TRADE JOURNAL.

JUNIOR Laboratory Assistant required to train as CUPOLA METALLURGIST.—Box 170, FOUNDRY TRADE JOURNAL.

REPRESENTATIVE required for the Sale of Industrial Leather Gloves and Aprons; must have sound connection amongst large users.—Write, in confidence, to J. MOON & SON, 94, Sclater Street, London, E.1.

WANTED.—Two young Men for responsible positions in large mechanised foundry; must have sound experience in foundry work and labour control; excellent prospects for right men.—Box 202, FOUNDRY TRADE JOURNAL. This advt. appears by permission of the Ministry of Labour and National Service under the Control of Engagement Order, 1947.

AGENCY

WANTED.—AGENTS for London, Midlands and Scotland, with established connections in Foundries, Engineering Works, etc., for the supply of Specialised Plant and Equipment.—Box 174, FOUNDRY TRADE JOURNAL.

BUSINESS WANTED

SUBSTANTIAL buyers Ferrous Castings considering taking interest Ironfoundry, minimum 10-ton weekly output, with possibility expansion; prepared purchase output long period, guaranteed prices.—Full details, in strict confidence, principals only, Box 192, FOUNDRY TRADE JOURNAL.

BUSINESS FOR SALE

PROGRESSIVE Non-ferrous Foundry for Sale, East Midlands area; excellent connections and goodwill, with orders both current and pending; suitable for two working partners or as Branch Foundry for Parent Company; latest certified balance-sheet for year ended 30th June, 1949, available to genuine inquirers; present proprietor desires to retire for medical reasons.—Box 176, FOUNDRY TRADE JOURNAL.

MACHINERY WANTED

URGENTLY WANTED.—All types of Foundry Plant, including Sand Mills, Cupolas, Blowing Fans, Hand and Pneumatic Moulding Machines, Sand Mixers, etc.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E., Crosswells Engineering Works, Langley near Birmingham. Broadwell 1359.

URGENTLY REQUIRED

SANDSLINGER. Royer No. 2 Machines.

FRANK SALT & CO., LTD., Station Road, Blackheath, Birmingham. BLA. 1635.

WANTED

FOUNDRY PLANT of all descriptions, including Cupolas, Hoists, Conveyors, Sand Mills, Moulding Machines, urgently required.

FRANK SALT & CO., LTD., Tessall Lane, Birmingham, 31.

MACHINERY FOR SALE

FOUNDRY PLANT.

CUPOLAS, Fans, Cranes, Hoists, Compressors, Runways, Sand Mills, Pulley Blocks, Conveyors, Steel-framed Buildings.

FRANK SALT & CO., LTD., Tessall Lane, Birmingham. Priory 1920.